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THESIS

THE ASHORE INFRASTRUCTURE REQUIRMENTS NEEDED TO SUPPORT MOBILE MAINTENANCE FACILITIES (MMF) FOR INTERMEDIATE MAINTENANCE ON THE NEXT GENERATION AIRCRAFT CARRIER (CVNX)

by

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December 1999

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ABSTRACT Intermediate Level Aviation Mobile Maintenance is currently conducted by the United States Marine Corps (USMC), Marine Aviation Logistics Squadrons (MALS) and also the USMC and United States Navy (USN) Electronic Warfare Community using a type of Mobile Facility (MF). The system is designed to be flexible and adaptable to changing mission requirements. Tbis tbesis investigates wbether the same type of system could be utilized on the next generation aircraft carrier (CVNX).

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Intermediate Level Aviation Mobile Maintenance is currently conducted by the United States Marine Corps (USMC), Marine Aviation Logistics Squadrons (MALS) and also the USMC and United States Navy (USN) Electronic Warfare Community using a type of Mobile Facility (MF). The system is designed to be flexible and adaptable to changing mission requirements. This thesis investigates whether the same type of system could be utilized on the next generation aircraft carrier (CVNX).

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I. INTRODUCTION

A. BACKGROUND

This research reviews the ashore infrastructure required to support the operational concept of using modular architecture for aviation intermediate maintenance on the next generation aircraft carrier (CVNX). The objective is to make recommendations as to the types; capabilities, quantity and mixture of ashore support equipment, manning, and support facilities necessary to fulfill this requirement. Given the flexibility of a clean sheet of paper design for the CVNX, we will examine what ashore infrastructure is required to support a modular type Aviation Intermediate Maintenance Department (AIMD) on the new class of carrier, similar to the mobile maintenance facilities currently utilized by the United States Navy (USN) and United States Marine Corps (USMC).

B. PURPOSE

Ever since the Battle of Midway during World War II, the strategic importance of the aircraft carrier has been reaffirmed time and again. When a crisis erupts anywhere in the world and the U.S interests are imperiled, an aircraft carrier and its Battle Group (CVB) are generally less than 48 hours away. Aircraft carriers and their attached airwings are primary participants in today's peacekeeping role due to their power, mobility, flexibility, sustainability, visibility and reliability. A key enabling factor for these qualities give strong and capable intermediate maintenance facilities aboard the carriers. The aircraft that compose the deployed airwing are the instruments used by the aircraft carrier to respond to volatile situations. The operational availability of naval aircraft determines whether they can perform they're prescribed missions and contribute to defense strategy. In order to meet mission requirements, maintenance must be performed on the aircraft and associated systems to

preserve and sustain their operational availability and meet sortie requirements.

CVNX will be the centerpiece of naval power projection well into the 21st century. The Navy is developing a new class of carrier that leverages technologies to reduce life-cycle costs and enhance warfighting capabilities. The CVNX design will begin to replace the existing Nimitz class carrier (CVN-68) in 2013. The eight Nimitz-class carriers were designed in the mid-1960's and have had incremental modernization over the life span of the current fleet. The design of this class, however, limits its growth capability, its ability to adapt to changing weapons and information technology, its ability to accommodate new aircraft, and its ability to reduce life cycle costs. The CVNX ship design will employ a total ship, aircraft, and engineering approach that optimizes life cycle cost (key drivers are manning, maintenance and process velocities) and performance. A modular architecture would provide future carriers with maximum operational flexibility, rapid and affordable reconfigurability, and ready adaptation to new missions and adoption of new technologies. Operational flexibility and room for growth is designed and built in.

CVNX should be viewed as "infrastructure for growth" in order to accommodate - during its 55-year life span - five to ten generations of computers as well as three to four generations of combat systems and three to five generations of aircraft. The modular architecture would provide the next generation carrier rapid and affordable reconfigurability, ready to adapt to new missions and adopt new technologies. If past experience is any guide, the "average" carrier will make 25 overseas deployments, respond to 20 major international crises, and see action in several regional conflicts over its nominal life span [Ref 1]. What will the capabilities of the carrier of tomorrow be? How will we modify future carriers to take advantage of the technology breakthroughs, which are sure to occur during its 50-year, plus life span?

Major changes in threats, missions, technology and budgets call for a review of the design of the aircraft carriers. With the notion of a zero-based design for CVNX, the concept of mobile facilities (MFs), capable of adapting to aircraft embarked onboard during the life of the vessel, becomes very attractive. The new design of the CVNX will incorporate architecture for change, blend emerging technologies to enhance its warfighting capabilities, while reducing the carrier's overall life cycle costs. Flexibility and room for growth must be designed and built in to incorporate fast advancing technological changes we see today.

The uncertainty in the future events, technology, budgets and new aircraft designs during the life span of CVNX emphasizes the need for a next generation carrier that can adapt to missions and circumstances that can not be foreseen today. CVNX will need to accommodate not only existing legacy aircraft (e.g. F/A-18 E/F) but the Joint Strike Fighter (JSF) and Common Support Aircraft (CSA) and their replacements/ modifications. Incorporating modular architecture will reduce cost, add flexibility, and allow for reconfigurability.

C. TYPES OF AVIATION MAINTENANCE

Maintenance on aircraft in the United States Navy is performed at three separate levels: organizational, intermediate, and depot (See appendix C). The basic guidance for all maintenance is the Naval Aviation Maintenance Program (NAMP) manual, OPNAVINST 4790.2 series. A basic precept to be remembered is that all repairs should be performed at the lowest possible level consistent with manpower, training, support equipment (SE), replacement parts, and technical data availability. The complexity of maintenance performed at an activity increases from organizational level, through the intermediate level, to the depot level for aircraft maintenance [Ref 2].

Intermediate level maintenance, the focus of this study, is accomplished both ashore at the Naval Air Station (NAS) and aboard aviation platform ships. When the ship is not underway, the aircraft squadrons in the airwing operate ashore at their home NAS's, and are provided intermediate level maintenance support by the AIMD at their respective NAS. Because of its proximity to the operating units and focused repair mission, the AIMD is the most responsive and least costly alternative for aviation repairable components to meet fleet requirements [Ref 2]. The AIMD also provides supply to the ashore operating environment and aircraft carrier supply assets, as well as a contingency source of quick turnaround repair for components not immediately available in the base or ship inventory.

While deployed, the squadrons that comprise the carrier airwing (CVW) are attached to the ship and are supported by the shipboard AIMD for intermediate maintenance. As with any city, support facilities are essential on an aircraft carrier. Most carrier AIMDs are honeycombed with specialized shops – electronics shops, communications, avionics and navigation equipment and repair shops to maintain all types of machinery and a/c [Ref 1].

This thesis will concentrate on the ashore infrastructure required to support a shipboard modular AIMD on CVNX, specifically during extended ship availability periods.

D. METHODOLOGY

To better understand mobile facilities and their potential use in Naval aviation intermediate maintenance, this research first provides a general overview of the mobile facility program, how it is organized today, and the requirements and responsibilities of those D0D organizations currently in the MFP. In this thesis, we investigate the cost associated if the avionics area of an aircraft carrier was placed in MF and

then sent ashore during availability periods to assist the NAS AIMD in intermediate maintenance.

In order to accomplish this the following resources were utilized:

- Department of Defense Publications
- Books, periodicals, Journals and electronic resources available at the Naval Postgraduate School (NPS) Library
- Internet web-sites pertaining to the organizations involved in the MFP.

In addition to the resources listed above, site visits to Marine Aviation Logistics Squadrons, Naval Aviation Depot North Island –(NADEP NI) a configuration site for MFs, A Nimitz-class aircraft carrier, and the Naval Air Systems Command (NAVAIR) were conducted by the author to collect information and data to assist in the study. Also, government personnel with key roles in the MFP were interviewed or contacted via electronic mail to obtain their assistance in the research. A questionnaire was sent to the Aerospace Maintenance Duty Officer (AMDO) community to gain insight into their views on deploying MFs onboard an aircraft carrier.

The primary limitations to this study are that it examines the existing structure for aircraft carriers and attempts to modify it to a system that will not be in the fleet until 2015, at the earliest. The cost of MF configurations and other areas were not available to assist in the analysis portion of the study. The proposed system will be implemented on a platform that will have a different airwing, different airplanes, and a different mission to accomplish than the current Nimitz-class carrier.

E. ORGANIZATION OF STUDY

This paper examines the logistical factors involved with employing a mobile aviation intermediate level maintenance on the next generation aircraft carrier and the associated costs if the avionics area of a carrier AIMD is incorporated into MFs. The current system of aircraft

intermediate maintenance is examined to identify the factors involved. The proposed system, moving the MF on/off CVNX while the ship is in an availability period, is formulated to determine the changes that are required, and the costs associated for implementation and operation.

Chapter II provides the reader background information on existing MF assets currently in the Navy inventory. This includes a brief overview of how the MF is complexed, responsibilities assigned to the program, location of the MF on CVNX, movement of the units, impact on test equipment and associated systems, and the current AIMD manning structure.

Chapter III describes the proposed system and the associated facility requirements from an ashore perspective. It discusses where the MF concept applies on the ship and when the MF with its associated equipment and applicable manning required to support it, should be placed ashore at the proposed site. The locations of the sites are discussed along with the transportation of these assets. The ashore infrastructure, approached from a facilities perspective, describes the pad construction, power requirements, and grounding issues. Manning of the proposed system is addressed at the end of the chapter.

Chapter IV is the overall analysis of the proposed system. The chapter focused on costs associated with implementing the proposed system, specifically from and ashore perspective. We examine the actual cost of procuring the MFs we need for our system, transportation costs required to move the MF back and forth from the ashore site to the aircraft carrier homeport, and the cost of ancillary gear that is unique to the system while ashore. We also identify the maintenance responsibilities and associated costs for the life cycle of the MF and identify the areas of concern with manning the proposed system ashore. The costs associated with configuration of the MFs need to be further identified, as well as those associated with the changes to our test gear as

the system will not be implemented at the earliest until the first CVNX has completed its first deployment, well after 2015. Alternatives to the proposed system identified in Chapter II are mentioned, and the impact the system may have on the Fleet from a "sharing of assets" is examined. The results of a questionnaire are briefly discussed and challenges the Aviation Maintenance Community foresees if the system is implemented are identified.

Chapter V provides a summary of findings, conclusions, recommendations, and potential areas for further research.

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II. BACKGROUND INFORMATION

A modular maintenance design will provide a program that is interchangeable, expandable, and tailorable to meet shifting missions and needs, as well as supporting changes of aircraft models during the 50 plus year life span of the CVNX. One method for meeting a modular design on CVNX is the incorporation of containerized systems. Container-oriented logistics support systems have become a significant means of supporting military forces. From a modest design beginning less than three decades ago, the use of Mobile Facilities (MFs) has expanded from an avionics system repair facility to include a wide range of maintenance/repair applications [Ref 3]. The basic MF is a fundamental tactical shelter 8 feet high, 8 feet wide and 20 feet long (dimensions of a standard ISO 9000 container) constructed of foam and beam material with an exterior surface of white painted aluminum (See Figure 1 and Appendix D). The MF is initially purchased at $20,000 and then internally reconfigured as a relocatable maintenance, supply, administrative, or operations facility.

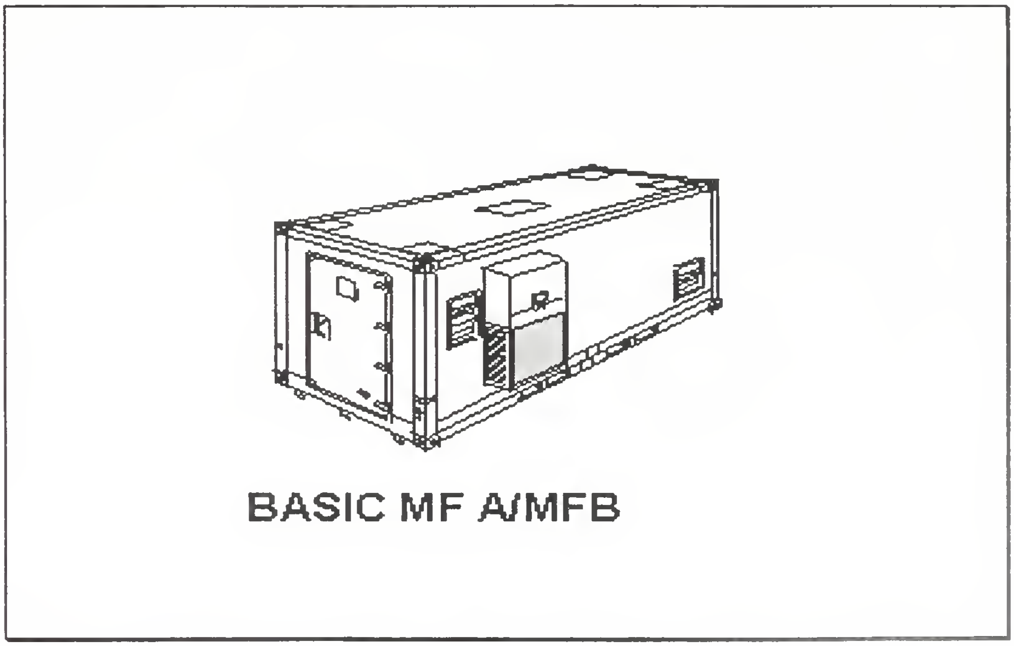

Figure 1 Basic Mobile Maintenance container [Ref 4]

Container-oriented logistics support systems have become a significant means of supporting the military. Specifically, a MF is defined as:

> *A habitable, relocatable, rigid walled tactical shelter. The overall MF Program is managed by Naval Air Systems Command (NAVAIR) and includes the MF and its ancillary equipment. The principal applications of a MF are to provide relocatable housing for aviation weapon system maintenance, to house SE or support functions, and to provide supply support facilities. MFs are also used to house equipment in support of aviation operational and tactical requirements that include automatic data processing functions (Ref 3).*

MFs are used aboard ship as well as ashore.

An MF will normally outlive the function for which it was originally designed. Therefore, the basic design of the unit must provide for multiple applications as well as for conformance with the DoD air and surface material transportation distribution system. Currently, MF shells are purchased from two commercial vendors (Gichner and Craig Manufacturing) and then configured at one of two configuration sites, located at either NADEP North Island (NADEPNI), CA, or Public Works Center (PWC) Norfolk, VA. MFs are then placed in active service after the configuration process. The site determines the serial number for the MF, selects appropriate engineering drawings for the user request(s), and begins work [Ref 3]. When work is completed, it is then "sold and delivered" to the fleet [Ref 5].

A. CURRENT MILITARY USERS OF MOBILE FACILITIES

Earlier in the 20th century, repairing and maintaining Navy and Marine Corps tactical aircraft was relatively simple. It was not uncommon to work on planes in tents, prefabricated shelters or on the airfield with common hand tools. However, with the introduction of highly complex jet aircraft and associated avionics and installed systems, the traditional World War II approach to repair and maintenance became

obsolete. Research determined that trailer type vans and/or workspace shops could be used to more effectively house the repair and maintenance activities that were peculiar to jet aircraft. The first use of vans occurred in the late nineteen fifties and and early sixties before the advent of the MF. Furthermore, at the time vans would provide a dust-free, temperature and humidity-controlled environment for servicing, testing, and repairing the complex avionics equipment on the aircraft. A standard-size van, called a mobile facility, was adopted in 1975 and the military commercial sea and containerization concept became a reality [Ref 4]. From that time on, all MFs in the DoD reflected International Organization for Standardization (ISO) and American National Standards Institute (ANSI) container requirements [Ref 4]. Today, MFs are serving a variety of customers as self-contained, portable workshops, capable of providing immediate and economical aircraft maintenance support.

1. United States Marine Corps (USMC)

Currently, the Marines utilize commercially available containers as aviation intermediate maintenance facilities. The Military Sealift Command (MSC) operates two T-AVB Seabridge class vessels, which are modified commercial, combination Roll On/Roll Off (RO/RO) cargo ships. The Seabridge-class vessels carry standard commercial ISO 9000 containers for Intermediate Level (I-level) support at MALS. The MALS incorporate a flexible "building-block concept," known as a Contingency Support Package (CCSP) and Peculiar Contingency Support Packages (PCSP), that follows a pre-arranged deployment or employment scenario for assembling the right mix of personnel, support equipment (SE), mobile facilities, and spare parts within a MALS to support deployed aircraft [Ref 6]. These "packages" can be rapidly configured to support the contingency aircraft mix, for both common and peculiar IMA and supply support for the various deploying aircraft. The MALS Program (MALSP)

encompasses a number of other programs that, together, enable aviation logisticians to integrate the people, support equipment, mobile facilities, and spare parts to support any given number and mix of aircraft. The MALSP provides numerous advantages, notably: standardized support packages, reduced embarkation and strategic lift footprint, rapid deployment and employment, and the ability to operate in austere locations.

2. Electronic Warfare Community

The EA-6B community utilizes expanded mission mobile maintenance facilities (EMMMF), modeled after the MALS, which are intended to be able to move to where the world trouble spots are (i.e., Bosnia, Turkey). The maintenance department at Naval Air Station Whidbey Island (NASWI) was tasked with providing homeport and deployed I-level maintenance (IM) support to the deployed EA-6B squadrons. The squadrons, and supporting IM detachment, have to deploy on 'short-' or 'no' notice, to trouble spots anywhere in the world without any infrastructure to support aircraft maintenance. The EMMMF is intended to house all the support equipment, test gear, tools, work tables and publications/manuals necessary to conduct maintenance on the EA-6B Prowler aircraft. The EMMMF is a self contained, workshop version of the MF, utilized by the EA-6B community to provide aircraft support/maintenance capable of being setup and operational within a few hours. These facilities are designed for land, sea, or air travel; and can be relocated with an aircraft squadron anywhere in the world. Many Nimitz class carriers have EA-6B test equipment (TE) vans already onboard and shock mounted in the forward hangar bay, starboard side (See Figure 2).

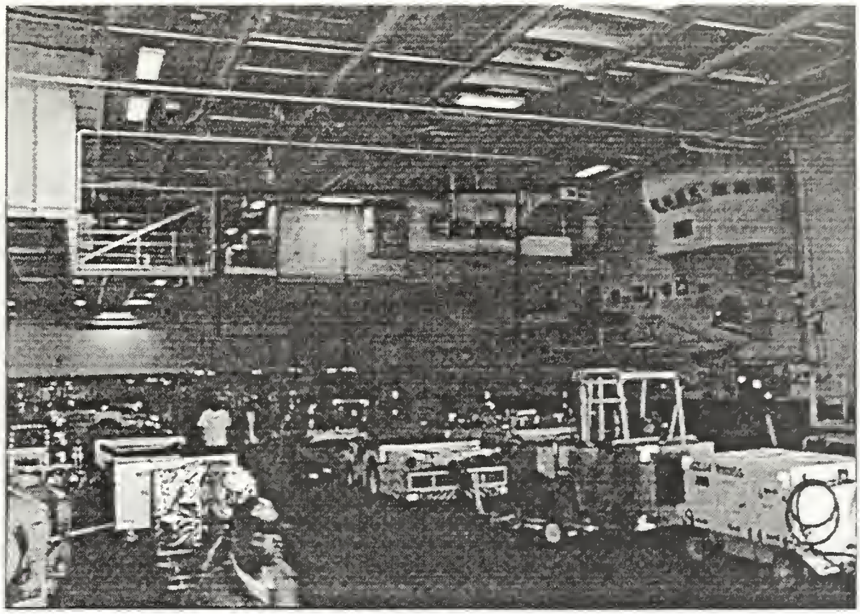

Figure 2 Location of EA-6B TE Vans on a NIMITZ carrier

Both the MALSP and EMMMF are capable of fully supporting all of the requirements of the USMC/USN Airwing squadrons. Various types of MFs can be configured and may be found in appendix E.

B. COMPLEXING

One of the most important features would be the ability to combine two or more MFs into a functional entity in order to perform a common task. This capability, called complexing, allows users to integrate several work functions into one environmentally controlled workspace (See Figure 3 for ashore layout). Complexing is normally accomplished by using a combination of basic mobile facilities, mobile facilities side opening (MFSOs), Integration Unit mobile facilities (INUMFs) and ancillary equipment such as butting kits, walkways, and electrical power distribution cables [Ref 4].

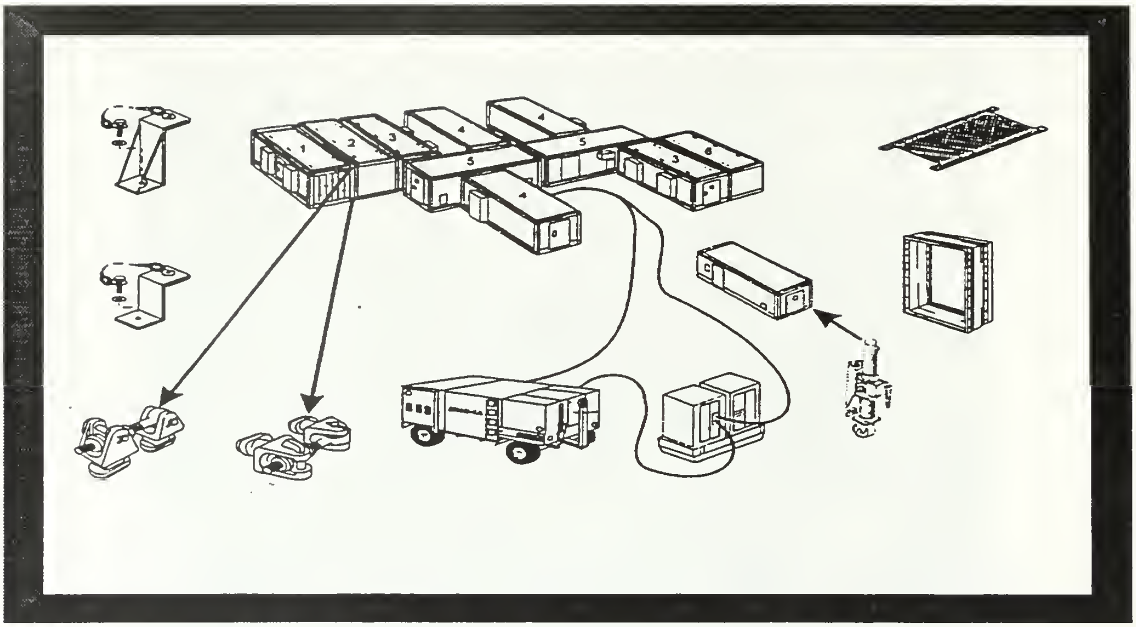

Figure 3 Ashore Complexing [Ref 4]

The key to mobile facility complexing is the integration unit, which has three removable side panels (two on one side of the unit and one on the other). Through creative planning, a mix of basic mobile facilities and side-opening mobile facilities can be used in conjunction with an integration unit mobile facility to create a basic complex [Ref 6].

Once mobile facilities and integration units are joined into a complex, butting kits are attached between the abutted shelters to form a weather-tight seal. By using a butting kit, basic mobile facilities can be joined to each other end-to-end, or to an opening in the integration unit mobile facility. Ancillary equipment such as walkways and power distribution cables are also installed. Complexing enlarges the entire scope of the Mobile Facility Program (MFP). While a single shelter may have restricted usefulness, an integrated complex can provide significant capability. Engineers continue to design mobile facilities to support functions requiring a high degree of mobility. Tactical and operational situations requiring enhanced mobility are expected to become increasingly common.

The objective of this project is to determine the ashore infrastructure requirements necessary to sustain a MF designed AIMD so that all aircraft embarked on CVNX are adequately supported.

C. RESPONSIBILITIES ASSIGNED TO MOBILE FACILITY PROGRAM

Management of the MFP will be accomplished within the functional organization of NAVAIR Head quarters (NAVAIRHQ). Management of the MF Program (within NAVAIR) is accomplished through the MF Program Manager (PM)[Ref 3]. Since most containerization is logistically oriented, the PM (Code 3.1B.4) will fall under NAVAIR Logistics Support Department (AIR-3.1). The PM will perform logistics and acquisition management, manage budgets and execute the MF program. Specific program policies within NAVAIR and other functional organizations are further defined in appendix F.

D. MODULAR DESIGN

One objective of applying modularity to the design and construction of U.S. Navy ships is to reduce acquisition cost through application of fewer, standardized system designs [Ref 1]. Modular construction is characterized by the use of standardized structural system architecture integrated with common equipment, components and piece parts [Ref 3]. Module components may be structural elements or standardized units that are grouped and assembled with others of a like kind to provide commonality with other systems and auxiliary service and distributed system interfaces.

Mobile facilities, which are a type of module, may take the form of a stand-alone, space, component, or system modules composed of standard and common equipment, components, and auxiliary service interfaces that perform specific functions and are ready for installation, hook-up, and operations. The use of MFs onboard/ashore will take advantage of

integrated design solutions that maximize efficiencies that result from applying standardized architectures during ship design and construction. A modular architecture design will provide a program that is interchangeable, expandable, and tailorable to meet shifting missions and needs as well as support the changes of aircraft (a/c) during the 50 plus year life span of the carrier [Ref 1].

E. LOCATION OF MOBILE FACILITY ON CVNX

When applying MFs to CVNX, the logical choice of workcenters to place in these facilities is the avionics/armament division, typically IM-3 on current CVNs (the choice of workcenters/divisions will be discussed in more detail in Chapter III). The avionics section of an AIMD is where the most frequent changes occur as technology advances and new equipment for the a/c is replaced and/or updated. A typical avionics division on a carrier has several "shops," including: generators, battery, instruments, Automated Test Equipment (ATE), communications, radar, electrical systems, navigation, EA-6B and F/A-18 avionics, Consolidated Automated Support System (CASS), and other facilities [Ref 2].

Many of these avionics spaces require frequent upgrades, which reduce the ship's operational readiness. Also, designing the work space required for the current a/c would be counter productive as many of the legacy a/c retire in ten to twenty years and replacements join the fleet (JSF, CSA, etc). The use of MFs will facilitate new and varied a/c and missions (Special Forces, humanitarian relief, etc). A benefit of using MFs onboard, particularly for avionics, is the ability to achieve acquisition savings and remove the onboard infrastructure from the ship during yard periods of non-use (i.e. long availability periods)[Ref 7].

If MFs are utilized onboard CVNX, specifically for the avionics workcenters, the possible locations for the MFs are up forward on the 01 and 02 level ("tunnel area"). Another possible location would be in the

hangar bay, in the overhead area similar to the current mezzanine on some of the CVN-class carriers (See Figure 4). This type of location is also refereed to as gallery deck modules, which is a containerized mission system integrated into an open gallery deck [Ref 7]. These MFs may be utilized for new functions, new a/c support, new missions and special missions. If the MFs are placed in the 01 and 02 levels they will be utilized for electronic workshops and storerooms, namely for aviation support. One possibility, although slim due to the already constrained space is to place the MFs in the hangar bay (main deck). Placement of the MFs on the hangar deck would be typically for temporary purposes only, such as repair, overhaul, or special missions.

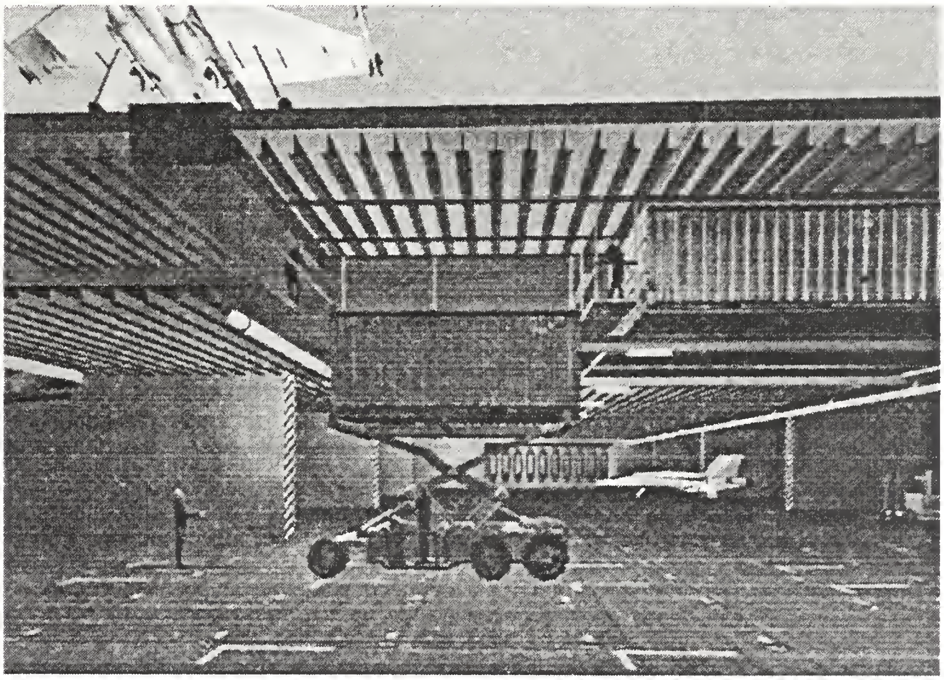

Figure 4 Galley Deck Placement of MF(s) [Ref 7]

In the future, other areas may be considered as well for MF use (See Appendix G). This includes main deck aft - the aviation structures shop, aviation composite repair, tire shop, oil lab, etc. Other areas include the

02 level midship – consolidated a/c pod storage and possibly aviation storerooms and administrative spaces.

F. MOVEMENT OF MOBILE FACILITIES

When considering cargo loading/offloading, it is important to remember that the MFs have similar stowage and handling characteristics as ISO 20-foot containers commonly found aboard commercial container ships, since they share the same overall dimensions and securing fittings [Ref 6] (See Appendix D). All MFs are fitted with skids, which protrude 2-1/2 inches beneath the MF and require spacer fittings for stacking.

1. Movement on/off the ship

The MFs may be moved on/off the ship either using the ship's Boat and Airplane (B&A) crane or the cranes normally utilized by the ship for loading general stores (responsibility of the Material Division, Supply Department on most CVNs). The stores crane is provided under a service contract from the base public works department and has a lifting capacity that is more than sufficient to lift a fully loaded MF on/off the ship. These B & A and stores cranes need to be operated in conjunction with a container spreader (See Figure 5) or be utilized with breakbulk loads. In the case a MF requires offloading by helicopter while at sea, then slings, nets, pallets, thimbles and turnbuckles may be required. These devices are supplied primarily for use in the lift off/lift on (LO/LO) operations and for miscellaneous material handling (e.g. breakbulk, heavy or outsize lifts).

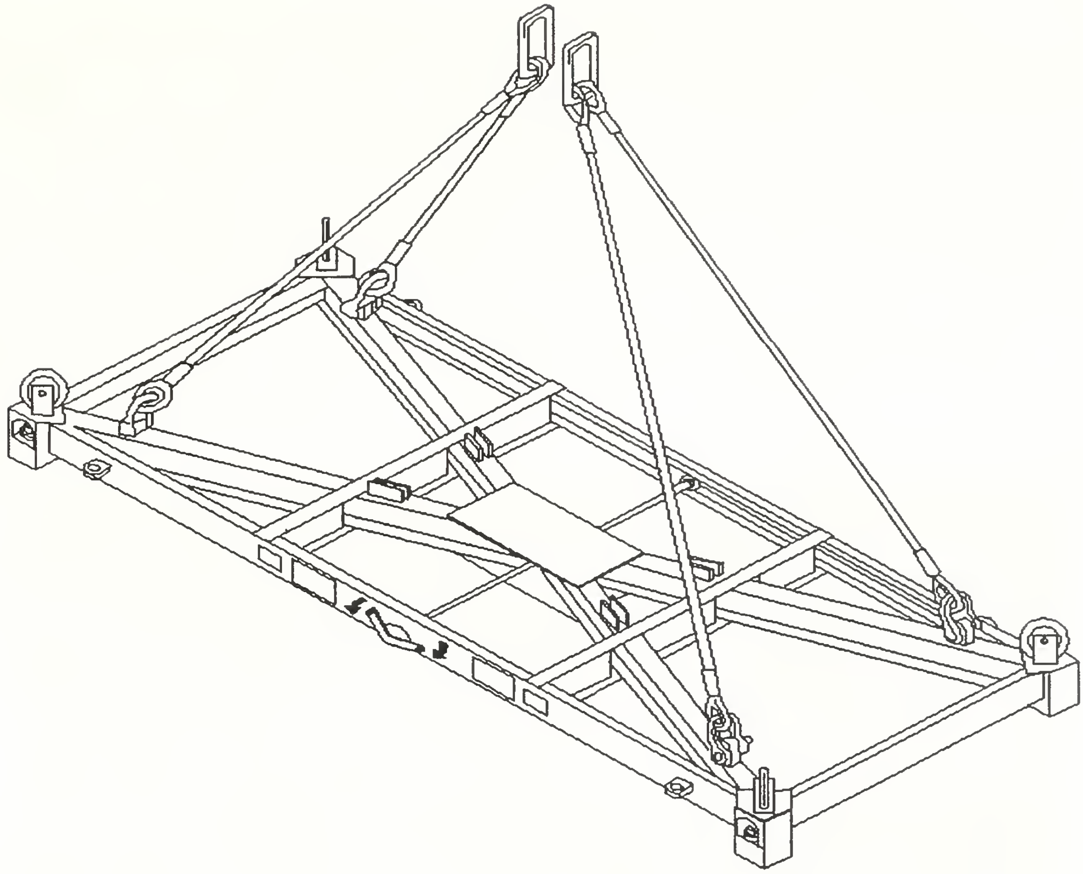

Figure 5 Spreader bar placed on top of MF

2. Movement while onboard or ashore

The MFs are also provided with reinforced forklift pockets to facilitate movement by forklift and contain Environmental Control Units (ECUs) which protrude approximately 18 inches from the side of the MF during operation [Ref 6]. Safety and care must be adhered to so damage does not occur to the ECU, which provide critical cooling for avionics gear (air conditioner). Material Handling Equipment (MHE) onboard the ship may be used to move MFs once onboard. When empty, most MFs weigh approximately 5300 lbs. and may be moved using the 6000 lb. forklifts onboard the carrier [Weapons Department – ordnance moving

electric style, Supply Department – Material Divisions stores forklift, or AIMD IM-4 Division, General Support Equipment (GSE)]. The carriers 20,000 lb. forklift will be the likely piece of MHE gear that will be utilized since most of the MFs that will require moving will have pre-existing ATE, avionics, test benches, CASS systems, desks and gear already installed.

To properly stow the MFs onboard, deck sockets and pad eyes need to be designed into the ship. An alternative internal rearrangement on CVNX is the SMART track foundation system (See Figure 6). SMART track is a foundation system that allows the fleet to reconfigure spaces to receive new systems, install equipment upgrades, position crossdecked systems or rearrange work areas without any industrial work and at significant cost savings [Ref 7].

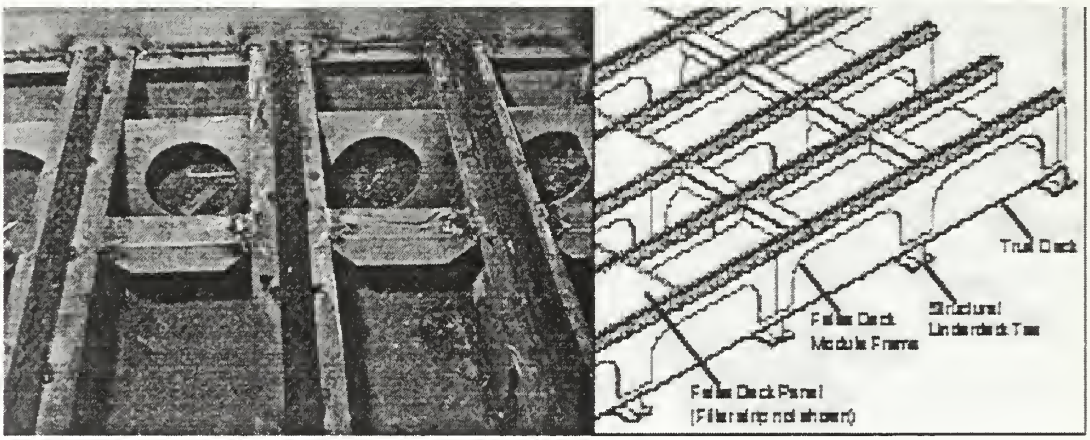

Figure 6 SMART Track System [Ref 7]

The track assembly is similar to the design of a bureau drawer or other piece of furniture that has a guide to direct the opening/closing of the drawer. The SMART track would act as a guide and place the MFs in a predetermined spot. SMART track allows for easy reconfigurability of

the MF and rearranging equipment aboard ship with out cutting and welding. It also allows for easier re-outfit of the MF ashore, allowing the MF to be used later without deckwork.

Some future design ideas to move MFs onboard the ship include a scissors lift (See Figure 7) with an omnidirectional wheel technology, consisting of a wheel hub encircled with a multiple elliptical rollers, lifted via winches (alternate to scissors lift) or on casters towed with conventional yellow gear.

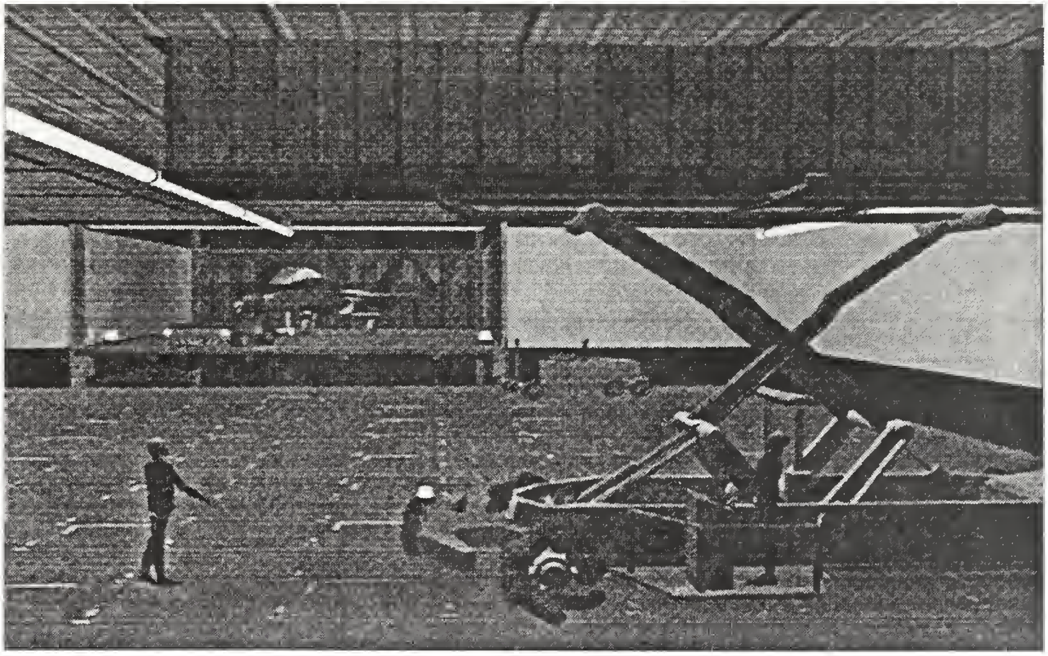

Figure 7 Scissors Lift [Ref 13]

3. In-transit movement to/from CVNX and to/from ashore site

The MF is designed to provide a fundamental shelter that may be further configured as a maintenance or operational facility. The MF is a completely enclosed, watertight unit, capable of protecting equipment in a controlled environment while also providing continued protection for the installed equipment when it is being transported (See Figure 8).

Each corner of the MF is equipped with an ISO fitting, with each fitting designed for a maximum load of 100,800 lbs. [Ref 6]. In the transport mode, the upper fittings can be used with overhead lifting devices such as cranes and helicopters to lift the MFs. Surface transportation is the normal mode of transportation for movements of MFs [Ref 3]. Air transportation is used to and from overseas only for those MFs containing sensitive SE or when operational considerations require urgent delivery.

The usual mode of transportation within CONUS for MFs is motor transportation utilizing air ride equipment. Rail transportation is not used to ship MFs due to the adverse shock and vibration present during rail movement and its adverse effect on the ATE and other avionics in the MF [Ref 3]. Transportation costs are charged to Naval Supply Systems Command (NAVSUPSYSCOM) first or second destination transportation funds. However, transportation costs for all fleet directed MF movements must be borne by the appropriate major claimant or Type Commander (TYCOM).

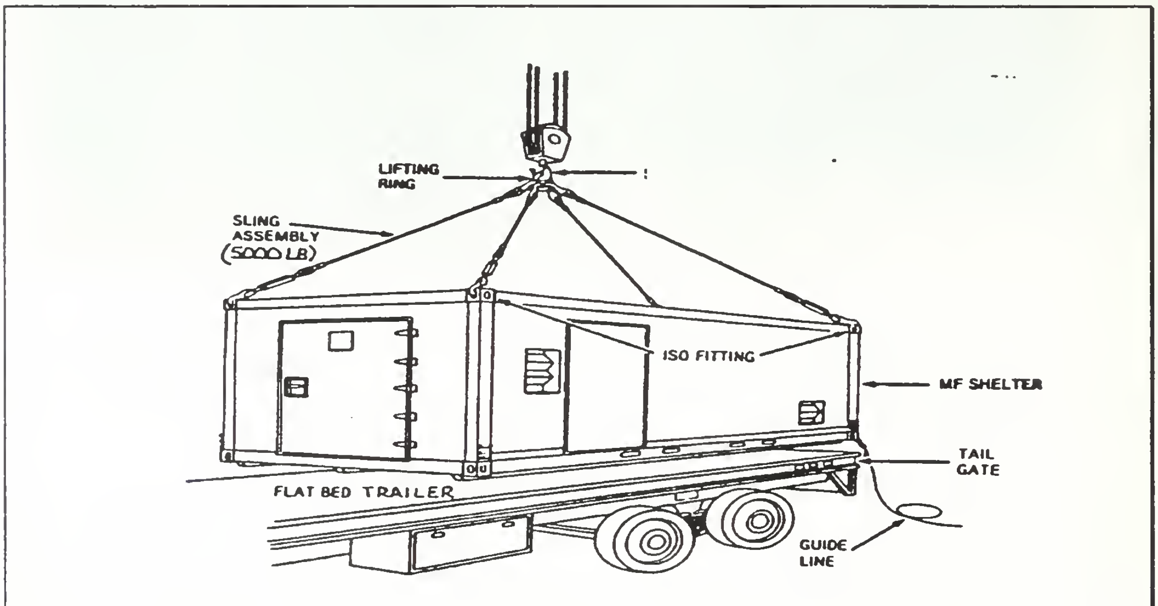

Figure 8 Loading MF on a trailer for transport

G. CONSOLIDATED AUTOMATED SUPPORT SYSTEM

CASS was developed by NAVAIR as the Navy standard ATE for support of electronic systems at the Intermediate Maintenance Activities (IMA) both ashore and afloat in addition to Navy depots. Since the CASS system will replace many existing ATE systems in the fleet, and are located in the avionics division on the CVN/CVNX AIMD, it is important to understand the various configurations of the system and basic functions (See Figure 9 and Table II-1).

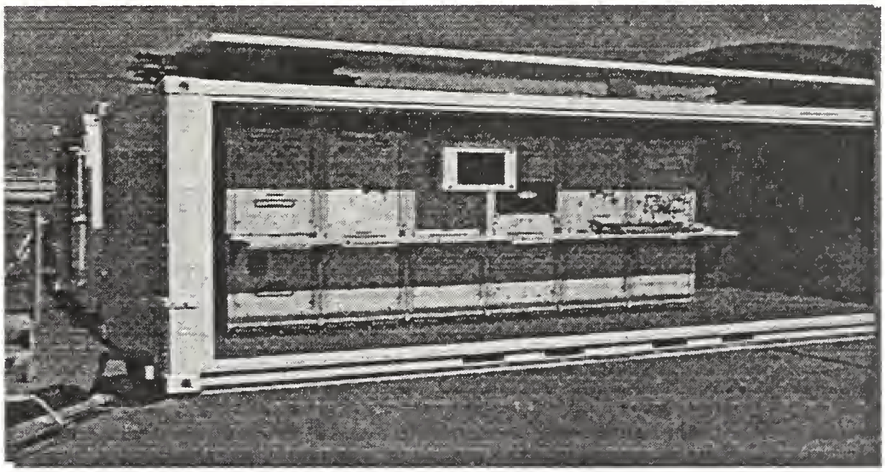

Figure 9 CASS workstation in MF

As the figure above indicates, the four CASS configurations were designed to be a common tester that could support the total electronic test requirements of the Navy and DoD. To avoid obsolesce and allow for upgrade for testing future technologies, CASS uses a flexible hardware and software architecture [Ref 8]. Some of the features originally designed for CASS are applicable to the MF concept. The use of standard architecture, with the ability to accept new technologies over time without TPS retrofits is one. Another is horizontal TPS transportability [Ref 8]. The last attribute allows for flexibility in workload sharing among testers, even of different CASS configurations. These factors result in both fewer types of testers and fewer total testers in the fleet and thus lower total ownership costs of the weapons system.

The CASS system uses an open architecture system (modular) that allows CASS to be more easily upgraded and supported over time. CASS and its associated stations Hybrid (HYB), Electro-Optical (EO), Radio Frequency (RF), and Communications, Navigation and Identification (CNI) require adequate space for the system and users to work. In the proposed system, discussed further in Chapter III, CASS would be placed into the MFs to support the avionics area of the IMA. Currently, each carrier will have onboard 18 CASS stations, with the latest addition a fourth RF with a High Power Device Tester (HPDT)[Ref 8]. Over the next few years, CASS will be replaced many existing ATE systems and help the Navy standardize test and training procedures.

HYBRID STATION	RF STATION	CNI STATION	EO STATION
Basic Test Station:	*Basic Test Capability Plus*:	RF Test Capability Plus:	Basic Test Capability Plus:
General purpose electrical / electronics Computers Instruments Flight Controls Plus Subsystems for Pneumatic Display Inertial Navigation	Electronic Counter - Measures Electronic Counter - Counter - Measures Fire Control Radar Navigation Radar Tracking Radar Surveillance Radar Radar Altimeter	Communications Navigation Spread Spectrum Systems	Forward Looking Infrared (FLIR) Lasers / Designators Laser Range Finders Visual TV Systems

Table II-1 CASS Stations [Ref 22]

The hardware costs for 1999 scheduled CASS configuration purchases (in FY 99 dollars) was obtained from PMA-260. The following configurations and average unit cost of each is: HYB $ 0.9M, RF $1.4M, CNI $1.6M, and the EO $2.5M. The HYB is the core unit to all configurations. The RF, CNI and EO stations are then created by adding a subsystem to the hybrid.

H. CURRENT MANPOWER STRUCTURE OF AIMD'S

Numerous personnel assigned to the aircraft carrier are involved either directly or indirectly with the support of flight operations. The AIMD on the carrier is responsible for the intermediate maintenance that is necessary to keep embarked aircraft mission ready. That department provides the aircraft maintenance support either through the use of "core" shipboard personnel or the Sea Operational Detachment (SEAOPDET) personnel. A SEAOPDET is a cadre of bench operators and apprentice level IMA augmentation personnel who are assigned to a sea duty unit identification code in the ashore IMA [Ref 2]. The SEAOPDET utilizes "A" school graduates as apprentice/bench operators in the performance of I-level maintenance on aircraft components and the operation of related support equipment [Ref 9].

1. Shipboard AIMD

The shipboard AIMD is responsible for providing I-level support facilities, and material for the embarked airwing. The ships are manned according to the Ship Manpower Document (SMD) that is issued by the Chief of Naval Operations (CNO), under the Deputy CNO (DCNO) for Manpower, Personnel and Training. The SMD displays by individual ships or class of ships, the quantitative and qualitative manpower requirements, and the rationale for the determination of manpower requirements [Ref 10]. The Naval Manpower Analysis Center (NAVMAC), based on the Required Operating Commitment (ROC) and Projected Operating Environment (POE), builds the SMD. For individual activities, the document is referred to as the Activity Manpower Document (AMD)(See appendix H). It identifies all the requirements and authorizations to an activity [Ref 11]. It also identifies how the requirements are to be funded.

2. Ashore AIMD

Shore station IMAs perform I-level maintenance support of assigned station and squadron aircraft, associated material, and equipment. The squadrons are manned according to the Squadron Manpower Document (SQMD) that is issued by the CNO, under the DCNO for Manpower, Personnel and Training. The SQMD displays by individual billets, the quantitative and qualitative manpower requirements of an individual aviation squadron, and the rationale for the determination of manpower requirements [Ref 10]. The ashore AIMD are manned according to the Shore Organizational Document (SOD).

3. Manpower

The Manpower Authorization (MPA) is the expression of the manpower requirements authorized by the CNO for a naval activity. The MPA is the authority used by the CNO to provide requisite military personnel distribution [Ref 11]. The SMD is the single official statement of organizational manning and billets authorized. Another document often used for manning is the Enlisted Distribution Verification Report (EDVR), promulgated monthly by the Enlisted Personnel Management Center (EPMAC). It indicates the ratings at organizations, Navy Enlisted Classification (NEC) codes, distribution NECs and any projected losses and/or gains. Manning and assignment decisions are made based on information contained in the EDVR. This document does not pertain to the officers assigned to the command. The EDVR is used in concert with the AMD by the activity to identify the enlisted personnel for funded billets.

Any change to the structure of the current shipboard AIMD would cause changes in the billet structure aboard ship and ashore. These changes would also impact the personnel onboard the ship that indirectly supports the AIMD personnel or the IMA process. If either workload or

equipment is transferred ashore, there is a high probability that AIMD personnel aboard the ship would be required ashore to sufficiently accomplish any "transferred" workload.

I. CURRENT MANPOWER STRUCTURE AND RESPONSIBILITIES OF THE MOBILE FACILITY PROGRAM

Large proportions of the initial and present inventory of MFs at the MALS are avionics maintenance, testing and repair facilities. Because the majority of assets were avionics, the MFP was placed under the command and staff of the Avionics Division [Ref 12]. This created the requirement for the Avionics Officer to be appointed to the billet and given the additional responsibility of Mobile Facility Coordinator. Maintenance, repair and upkeep of the mobile facilities and its associated ancillary equipment is to be performed by Ground Support Equipment (GSE) personnel working in work center 990 within the Avionics Division [Ref 12]. Although the designation of a 900-series work center falls within GSE, work center 990 is an exception to the rule.

A review of the manpower and organizational structure was carried out beginning with the Table of Organization (T/O) number 8810 for a MALS. This T/O describes the organizational structure and manpower requirements of units in terms of grade, Marine occupational Specialty (MOS) or civilian occupational series, billet title authorization, and personnel strength for the Marine Aviation Logistics Squadron. It is the basic document that describes the composition of every Marine Corps organization in billet line detail. The T/O for work center 990 of a MALS consists of six (6) Marines broken down as follows: (1) GySgt MOS - 6073; (1) SSgt MOS - 6073; (2) Sgts or below MOS - 6072; and (2) Sgts or below MOS - 6073. This staffing is to accomplish the maintenance requirements and program management of the third largest program in Marine Corps Aviation, behind aircraft and Individual Material Readiness

List (IMRL), which refers to test equipment and other support equipment necessary to support aircraft operations. The 990-work center is supplemented in its maintenance requirements by augments from "users" of the mobile facilities.

To get a clearer picture of the maintenance requirements and expectations of the Marines assigned to work center 990 let us review the facilities and equipment assigned to MALS-31. MALS-31 has 395 MFs, 380 ECUs, and over 600 pieces of ancillary equipment to maintain, perform periodic maintenance requirements, and repair when necessary [Ref 12]. With a "core" of six GSE personnel, a GySgt and SSgt performing the supervisory functions, there are a remainder of four "trained" and "qualified" Marines to perform the maintenance tasks on over 1300 items. To supplement the "core," augments are assigned to work center 990 from the "users" of the facilities. A majority of the augments come from the Avionics Division since this department has the preponderance of the mobile facilities [Ref 12].

Ironically enough, the Navy realized that as their mission focus began to include the use of mobile facilities (EA-6B EMMMF and others), they lacked the managerial and technical knowledge of the Mobile Facility program. The Navy then created an occupational field within their GSE to place the sole structure and technical "know how" within one area. In addition, they sponsored the creation of a mobile facility course at North Island, California and at Jacksonville, Florida to train personnel on mobile facilities, power cables, complexing and decomplexing facilities and peculiarities of the MF program [Ref 12]. The course is two weeks in duration and offered 12 times a year.

III. PROPOSED ASHORE AIMD SYSTEM AND ASSOCIATED FACILITIY REQUIREMENTS

A typical carrier AIMD is organized around four primary divisions, with several workcenters under each individual division. Because of the nature of work, technological change, adaptation and flexibility of these workcenters, certain areas are receptive to the MF maintenance concept as previously discussed in the preceding chapter. Predominately, the IM-3 division (Avionics) is where the "lion share" of frequent changes and updates in technology occurs [Ref 13]. It is this area the scope of the paper will concentrate.

AIMDs provide intermediate-level maintenance support for squadron operations.

> *The I-level maintenance mission is to enhance and sustain the combat readiness and mission capability of supported activities by providing qualify and timely material support at the nearest location with the lowest mutual support at he nearest location with the lowest practical resource expenditure [Ref 2].*

Currently, intermediate maintenance on USN/USMC aircraft is performed either ashore at the Naval Air Station/AIMD and MALS or at sea aboard Naval Ships (for this study only CVNs are considered). The shipboard AIMD typically provides maintenance support for 80 aircraft: three F/A-18 squadrons for attacking enemy targets; one F-14 fighter squadron; one S-3 multi-mission support squadron; one EA-6B electronic warfare squadron; one E-2C surveillance, command and control squadron; and one SH-60 multi-mission helicopter squadron [Ref 14]. Large proportions of the MFs utilized by the MALS and EA-6B communities are for avionics maintenance, testing, and repair. The various types and styles were previously discussed in Chapter II, and the various versions may be found in appendix E. The aviation logistics functions of the MALS include

aircraft, avionics, SE, maintenance, aviation supply, flight equipment, and maintenance data collection [Ref 3].

An important point to remember for this study is that the first CVNX will not join the fleet until 2013, and its follow on ship CVNX-2 until the 2018 time frame (See Table III-1). The first CVNX will have a new electrical power distribution and distribution system, zonal distribution, a new propulsion plant (nuclear power), and possibly a state-of-the art flight deck with an electromagnetic aircraft launching and recovery system [Ref 15]. The first and third points mentioned above will likely effect the proposed system described in this chapter. Both the electrical generation and distribution system and the new propulsion plant are key enablers for future technology insertion. One of the major benefits the MF provides is the implementation of technology upgrades and advances.

AIRCRAFT CARRIER	HULL	HOME PORT	COMMISSIONED	ESTIMATED RETIRE
KITTY HAWK	CV 63	JAPAN	29-Apr-61	2003
CONSTELLATION	CV 64	N. ISLAND, CA	27-Oct-61	2008
ENTERPRISE	CVN 65	NORFOLK, VA	25-Nov-61	2013
J.F. KENNEDY	CV 67	MAYPORT, FL	7-Sep-68	2018
NIMITZ	CVN 68	RCOH	3-May-75	2025
D.D. EISENHOWER	CVN 69	NORFOLK, VA	18-Oct-77	2027
CARL VINSON	CVN 70	BREMERTON, WA	13-Mar-82	2032
T. ROOSEVELT	CVN 71	NORFOLK, VA	25-Oct-86	2036
ABRAHAM LINCOLN	CVN 72	EVERETT, WA	11-Nov-89	2039
G. WASHINGTON	CVN 73	NORFOLK, VA	4-Jul-92	2042
J.C STENNIS	CVN 74	N. ISLAND, CA	9-Dec-95	2045
H.S TRUMAN	CVN 75	NORFOLK, VA	25-Jul-98	2048
RONALD REAGAN	CVN 76		2003	2053
	CVN 77		2008	
	CVNX 1		2013	
	CVNX -2		2018	

Table III-1 Aircraft Carriers

Also, technology may allow the CVNX to be built so that it will need to be refueled only once during its entire 50-year life, much better than the 1960's designed power plant delivered to the fleet for NIMITZ

class ships. This will effect the shipyard schedule, which will be discussed in paragraph B, this chapter. The earliest opportunity to apply modular architecture into the CVX platform would be the second aircraft carrier of the class [Ref 15]. Therefore the MF concept and the proposed system organization would likely not make it to the fleet until 2018, almost 20 years from now.

An Analysis of alternatives (AOA) was completed to determine the type of a/c and the size of the airwing which best meets the mission needs of battlespace dominance, power projection, and Command, Control, Computing, Communication, Intelligence, Surveillance and Reconnaissance (C4ISR) capability [Ref 16]. Another factor to consider is that when CVNX-2 enters the fleet, the F-14 will likely be retired, the JSF should be developing and some follow on designs/alternatives will be in the pipeline for replacement of the airwing common support type a/c (i.e. E-2, S-3, EA-6B).

The JSF maintenance concept assumes no I-level maintenance repair capability is required, basically an O to D level repair. If one or more of the embarked CVW squadrons does not require ashore or shipboard AIMD repair capability, then the associated ATE will not be required, and hence our footprint to support this a/c will be reduced. That will be a significant impact to the proposed system further on in the future. Moving from O to D is potentially a risky step and further analysis is required prior to implementing this shift in aviation maintenance. Further research is required to determine is this is a valid presumption or smart decision to move from the existing three levels of repair to two (as it applies to JSF and this thesis).

A. SHIPBOARD AIMD LOCATIONS FOR MOBILE FACILITIES

Currently, avionics workshop vans for EA-6B Prowler a/c on CVN's and MFs on LHD's for the AV-8 Marine Corps Harrier Jump Jet a/c are

used aboard ship in the Navy. The modularization of these assets provides several benefits, including: easy upgrade with minimal downtime for the ship, use of these assets to support airwings that have disembarked, and sharing of assets among the different ships of the fleet [Ref 7]. Today, the CASS system used to maintain and repair avionics is frequently updated, and requires a shipyard period to do so. This is a costly procedure (as much as $12M to place CASS on a carrier) and pulls the ship away from the active duty to do so [Ref 13].

By modularizing avionics shops and placing them in MFs, the entire shop can be replaced quickly and without cutting individual equipment items from the deck. The MF can then be taken ashore to be upgraded and the maintenance crew can test, evaluate and then train with the new equipment before it is installed aboard the ship [Ref 7]. These same assets can also be used ashore at the NAS AIMD to augment the ashore infrastructure, capabilities, and manning and/or be utilized by other carriers.

The IM-3 Division (See Table III-2) onboard the aircraft carrier has numerous shops under its cognizance, including the avionics section, which is predominately located in the forward portion of the ship (hangar bay one, main deck) in an area known as the tunnel, and also on the 0-1- and 0-2 level forward as well. A majority of the aviation avionics spaces require frequent upgrades in technology, T/M/S of a/c, and mission requirement changes, which reduce the ships' operational readiness [Ref 17]. Some work centers cannot be feasibly converted to a MF concept. The workcenter may use large equipment or require a large volume of space (footprint) to perform its work (e.g. power plants, airframes, calibration shop, and most/all of IM-4). However, although the entire workcenter may not be able to convert to a MF concept, some of the shops' smaller equipment might be consolidated and included in some sort of MF. The difficulty then lies in accountability of the "small

equipment," so it is not "misplaced." The use of MFs in avionics would also provide potential acquisition savings (sharing of assets, standardized spaces cut down on design costs) and maximum operational flexibility [Ref 7].

Aircraft Maintenance Shops	
Shop 1	CSD / Generators / Battery
Shop 2	FLIR / LASER
Shop 3	ComSec / DECM
Shop 4	Instruments / 2M / Cable Repair
Shop 5	ATE
Shop 6	Electrical Systems
Shop 7	Radar
Shop 8	CASS
Shop 9	Comm / Nav / ASW
Shop 10	F/A-18 Avionics
Shop 11	TARPS
Shop 12	Calibration
---	VANS - EA-6B Avionics

Table III-2 Aircraft Carrier IM-3 Maintenance Shops

If MFs were employed in the avionics areas of CVNX, it would provide the option of removing the aviation support system infrastructure from the ship during periods of limited or non-use (see section B below for more information on this issue). Applying the MF concept to avionics, in a similar but scaled down version of how the MALS presently operate will require additional areas to study when adopting this proposed system. Given that the USMC and EA-6B community have utilized MFs for years, their input to design of the MF would be invaluable and essential to ensuring that the proposed system has the best design and type of MF

currently available to meet any challenge. A modernized MF coupled with optimized ECU's to support the avionics environment is crucial to make this a viable plan. The remainder of this chapter will look at when MFs should be offloaded ashore, their location, who is responsible for them, transportation, facility requirements and infrastructure and conclude with a section on manning impacts.

B. APPROPRIATE OCCASIONS FOR OFFLOADING MOBILE FACILITIES TO THE ASHORE SITE

Following each six-month deployment, a ship will typically enter a major maintenance availability period to accomplish long term planned maintenance and equipment upgrades. This is normally where the majority of AIMD modifications, improvements and insertion of new SE occurs. Following the initial six-month shakedown upon commissioning, and the four-month post shakedown availability (PSA). The carrier's life consists of a set of 18-month cruise periods separated by planned incremental availabilities (PIA's) [Ref 18]. During every third PIA, the carrier will be placed in dry dock for upkeep; the others are accomplished along a pier. The docking PIAs (DPIAs) are planned to take approximately 11 months each; the other (PIA) are planned to take six months. At midlife, the carrier goes through a refueling/complex overhaul (RCOH). The RCOH for NIMITZ class ships will occur at approximately midlife (23-25 years) and is expected to take 32 months to complete. As discussed previously, if CVNX takes advantage of new technologies and lessons learned in the submarine community, it is possible that the next generation carrier will not need a 32 month mid-life refueling RCOH.

The optimal time to offload MFs for use ashore are during 30 days after deployment (standown period), after the ship is no longer the designated surge aircraft carrier, or during PIA, DPIA and RCOH. Upon completion of PIA, DPIA and/or RCOH the ship begins the basic Inter-

deployment Training Cycle (IDTC). This phase focuses on individual and unit level training. The ship then undergoes basic training and assignment to a battlegroup. The ship will be subject to high intensity, integrated, inport and underway inter-deployment work-up cycle that culminates with a two-week Joint Task Force Exercise (JTFEX) certification exercise [Ref 18].

The airwing (CVW), as well as the trainer a/c in the early stage of IDTC trainer a/c, are embarked on the CVN/CVX during the early stages of the predeployment work ups. The CVW initially trains at NAS Fallon, NV prior to beginning its year long work up cycle to fully integrate the airwing with the aircraft carrier. During the work up cycles prior to deployment, all ATE and AIMD personnel must be onboard the carrier so the airwing gets the proper I-level maintenance support it requires. It is neither feasible nor desirable to offload the MFs ashore during the intense IDTC period when the CVW and its squadrons are embarked.

C. ASHORE LOCATION

This thesis considers placing the MFs ashore and setting them up with a shore AIMD. Other options such as sending MFs ashore (non-operational mode) for storage or ashore to a remote site (e.g. Patuxent River, MD) will not be considered and require additional research that is beyond the scope of this thesis. This paper will assume that when the MFs are offloaded ashore, they will be operationally utilized

In July 1961, the “base loading plan” was executed, wherein some naval squadrons were relocated to major naval air stations based on aircraft type vice airwing assignment. This realignment of air wing squadrons was carried out to consolidate maintenance support facilities for individual a/c as a cost saving measure [Ref 14]. Currently there are 10 active and one reserve carrier airwings that support 12 aircraft carriers.

AIMD's are located near the NAS's throughout the continental United States (See Figure 10). Of the ten active duty airwings in existence today, all but one has assigned squadrons over four or more Naval Air Stations. As mentioned previously, the IMA provides support at the nearest location and is therefore located at the NAS AIMD to complete that maintenance mission. The one remaining airwing, CVW-5 with all

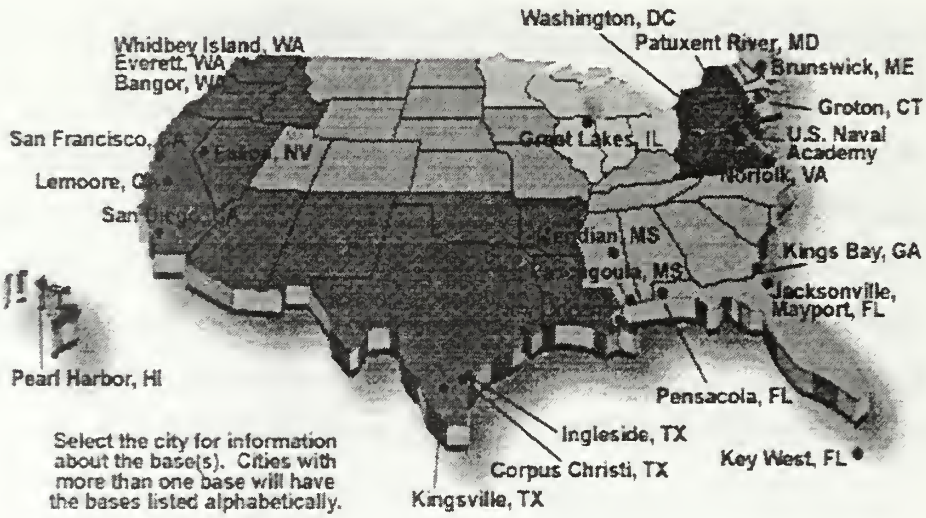

Figure 10 Location of Naval Air Stations

carrier based a/c T/M/S at one location/base, is at Naval Air Facility (NAF) Atsugi, Japan. Assuming 10 airwings, at any given time, one of these airwings will be forward deployed, four would be deployed from the west and east coast (two per coast), and four would be supported in CONUS at the ashore AIMD.

1. West Coast Assets

A CONUS CVW such as CVW-11 is comprised of the following squadrons: one F-14, three F/A-18 (C/D and E/F variants), one EA-6B, one E-2C, one S-3 and one SH-60. The airwing staff and three F/A-18 squadrons are located at Lemoore NAS, CA. The E-2 squadron is located

at Point Mugu, CA. The S-3 and SH-60 squadrons at NAS North Island, San Diego, CA. The EA-6B squadron is located at Whidbey Island, WA. Finally, the F-14 squadron is located at Oceana NAS, VA. As mentioned previously, the F-14 will not be in the aviation inventory when CVNX reaches the fleet approximately 20 years from now. The airwing is spread over five airstations and three states, which isolates the various squadrons from their airwing and would make offloading the MFs ashore to the supporting NAS AIMD a logistical challenge. This will be discussed in further detail in Chapter IV.

To further compound the issue, the West Coast carriers are located at three different naval bases (see Table III-1). The two aircraft carriers to the north (in Washington State) will further increase the transportation costs of moving the MF to the assigned AIMD ashore. So, which carrier returns from deployment and completes its 30 day standown, offloads its weapons and is relieved as the surge carrier (i.e. ripe for MFs going ashore) determines where the MF is offloaded from, and the distance it will have to travel to get to the appropriate ashore AIMD. The transportation cost will be a huge cost driver in this proposed system, as will the potential cost of damage due to the constant movement of the MF.

2. East Coast Assets

The east coast CVW's and Norfolk-based aircraft carriers are not as geographically dispersed, with the exception of the USS J.F. Kennedy which is located in Mayport, FL in close proximity to the Jacksonville NAS based S-3 and SH-60's and their ashore AIMD's. Most of the CVW squadrons are in the Tidewater, Virginia Beach area with the exception of the EA-6B (which only has one home base, Whidbey Island, WA) and the previously mentioned Jacksonville based S-3 and SH-60 squadrons. The F/A 18 and F-14 are located Oceana, VA and the E-2's at NAS Norfolk, VA.

One exception to this rule is the CVW that has assigned a USMC F/A-18 squadron, which is home based in Beaufort, SC. Again, the airwing is geographically isolated, over four airstations and three states, which would also make offloading the MFs a logistics challenge.

D. RESPONSIBILTY AND OWNERSHIP ASHORE

Another area of concern with the proposed system will be with establishing MF ownership. No one organization in NAVSEA or NAVAIR has cognizance over MFs in the Navy [Ref 3][Ref 7]. If MFs are placed on CVNX, and taken off to operate ashore in scenarios discussed, then NAVAIR and the naval aviation community need to take responsibility for the MF and equipment inside [Ref 7]. The MF would then no longer be a ship space, but NAVAIR equipment. NAVSEA and the carrier community would be responsible for maintaining the ship services interfaces, ship structural support, and the yellow gear to move the MF into place. In this manner, when the MF moves shoreside, aviation personnel can care, maintain, train with, and upgrade the MF. NAVAIR can then provide the MF fully outfitted for reinstallation, without the need to hand-carry spares and supplies onboard before IDTC commences.

When procuring new SE that will be destined for avionics, and hence MF usage in this system, NAVAIR PMA 260 needs to coordinate with the MF PM and Assistant Program Manager for Logistics (APML) to ensure the equipment is compatible in size, weight, power requirements and shore/ship interfaces [Ref 3].

Previously, responsibilities of the MFP were discussed in Chapter II and can also be found in Appendix F. Since the inception of the USMC MFP, the responsibilities of the facilities have been under the Avionics community (AO-Avionics Officer). The NAVAIR PM, Code 3.1B.4 is the overall manager of the MFP, responsible for logistics, acquisition management, budget management and execution, configuration and

outfitting [Ref 3]. A USMC Captain currently is assigned that billet. If the Navy pursues and places MFs on CVNX, and then ashore as proposed based on the aircraft carriers yard periods, then either additional USN personnel will either need to augment the existing NAVAIR Code 3.1B4, or establish a new internal organization that closely mirrors the existing one. Also, the MFs that were previously on the aircraft carrier will now have to be maintained and supported by someone. This is addressed later in the paper.

Use of AFM money is authorized for O-level and I-level maintenance of MF equipment. The Navy Working Capital Fund (NWCF) funds repair parts for O &I-level maintenance of the MFP equipment and replenishment of initial inventory funded per TYCOM Instructions [Ref 3]. Operational costs, preventative and corrective maintenance, consumables (oil, filters, fuel for any diesel generators, etc) need to be budgeted and funded by the cognizant TYCOM. Cost issues will be addressed in the analysis portion of this paper, in the next chapter.

E. TRANSPORTATION OF MOBILE FACILITIES

Once the afloat IMA tools, test equipment and applicable MFs are no longer required aboard the ship, they would be transferred to shore based AIMD's. A conventional pier or mobile crane can make the lift using a container spreader bar (See Figure 5)[Ref 19]. Costs would arise from the transportation of the MFs from the ship to the appropriate shore AIMD. Consideration must also be given to the fact that the additional costs generated from transportation from the ship to the ashore AIMD is above and beyond the costs associated with providing the infrastructure ashore to support the MFs. The cost of moving the MFs from the ship to the ashore site and vice versa are a significant factor in this proposed system. Another factor to consider with the multiple moves is the time, effort, and potential damage that would occur when moving the MFs.

Many costs are generated when transferring the I-level support. The costs associated with a ship experiencing a period in the shipyard was considered. This is the period discussed previously that the shipboard MF assets would be pulled off the aircraft carrier and transferred ashore to the applicable NAS AIMD. The industrial environment (shipyard) is not conducive to ATE or test equipment and the standard procedure is to offload much of the Individual Material Readiness List (IMRL) gear on the ship. The ships undergoing availability have usually pulled off as much equipment as possible, even installed benches [Ref 20]. The costs involved with a ship experiencing a period in the shipyard include the costs for storage and accountability of the ship equipment while the ship is undergoing repair. The installation of the ship's equipment aboard the ship at the end of the yard period must also be accounted for.

1. Shipyard Comparison

Representatives from COMNAVAIRLANT (CNAL) were contacted to determine the process involved when a ship is being prepared for repair or overhaul [Ref 20]. A breakdown was recently completed on the costs associated with the upcoming USS Dwight D. Eisenhower (CVN-69) RCOH offload/rework project by CNAL Code N422B2DC. The costs associated with this yard period are split into two phases.

a. Phase One

Phase one consisted of offloading all ships AIMD IMRL by a commercial field team; manpower and transportation were required for approximately 5500+ line items. An inventory on the items was conducted, and items evaluated, and separated. Also, packaging and preservation were performed as necessary and these items were redistributed as required. Some temporary storage was required prior to warehousing prior to some of the SE transferring to long term storage. Additional steps outside this study were for preparation for depot rework

and actual schedule and funding of the rework (including transportation and manpower required to move the items).

b. Phase Two

Phase two included the onloading preparation for the IMRL (including removing from storage, represerving items, etc) and the actual onload of the material. The big cost drivers for phase two is the transportation costs, crane services, and manpower.

c. Total cost of Shipyard offload

The actual costs for manpower alone was estimated at $4.675 million (this included SE rework)[Ref 20]. The area of focus for this comparison to the proposed system is the transportation segment of the phases. That area, which included trucking/shipping, storage, commercial field team labor and crane services were projected to add an additional $1.0 million to the price above, making the overall estimate for the CVN 69 project approximately $5.675M [Ref 20].

2. Cost of Transportation

Under the proposed system, after the applicable AIMD MFs and associated equipment is removed from the ship, it must be transported to the ashore site that has been selected. Costs would differ based on the movement outside the local Fleet Industrial Supply Centers/Public Works realm of responsibility and those within, where Public Works would provide the transportation assets [Ref 21]. As mentioned previously, the location of the aircraft carrier's homeport and the distance to the ashore AIMD will determine overall transportation costs when the proposed system is implemented [Ref 22]. An analysis of the transportation costs can be found in Chapter IV.

3. Material Handling Equipment (MHE)

Unloading and loading, stacking and unstacking, and moving MFs and associated equipment involves the use of MHE, operated by properly trained personnel. A 20,000 lb forklift or rental form the base public works department would be required at the proposed ashore facility to accomplish the required complexing and decomplexing of MFs [Ref 3]. If procured, the forklift would need to be added to the applicable WSPD/IMRL as appropriate. Also, a preventative and corrective maintenance schedule would need to be created responsibility assigned to perform the maintenance on the forklift. Additionally, necessary repair parts, petroleum, oil and lubricants (POL), and other expenses will need to be identified for the forklift. A basic Model W200Y 20K forklift, listed under contract DLA730-92-D-8002 cost $58,029 in July 98 [Ref 4].

4. Air transport option

The proposed system is concerned mainly with transport by air ride tractor-trailers, moving from/to the CVNX and the ashore site. Should the need arise to transport MFs quickly to areas of the globe not serviced by commercial lines or if speed is of the essence, then the added capability of moving MF assets by air provides greater flexibility to deployed units. If speed is not critical or the number of MFs is large, then either local road transportation or seaborne transportation is available by containerized vessels [Ref 22].

Presently, the current rigidly constructed MF is voluminous and places space constraints on the current fleet of military a/c. Two MFs fit snugly within a C-130, four in the C-141B, six in the C-17A and ten in the cavernous interior of the C-5A [Ref 19]. If the MF were less rigid, perhaps with "collapsible" sides as discussed under types of MFs earlier in this chapter, more MFs would be able to be expeditiously transported via airlift. The SE and miscellaneous other items in the MF would have

to temporally be removed from the interior of the MF, but a greater quantity of the IMA would be able to be airlifted with a less rigid structure.

5. Accountability of MFs

Also, a means of inventory control/tracking system will need to be created to correctly identify proper MF inventories. Currently an equipment list (OPNAV 4790/73A) is used to provide a record of equipment installed or in-use, and provides an inventory record for reports [Ref 2]. The Support Equipment Resources Management Information System (SERMIS) should be utilized for this inventory management. SERMIS would provide on-line visibility of source, allowance, inventory and rework data to aid in inventory control [Ref 2]. This system will be crucial when MFs are being moved on/off the carrier and to/from the proposed system ashore.

F. SITE PLAN AND SITE SURVEY

Once MFs have been offloaded, a site is required to place them ashore at the proposed site so they may be operational. The site plan is essentially a planned map of the proposed MF complex. A site plan is a graphic representation of a MF complex identifying each MF and showing amenities such as: connection points for telephone, data, and utility lines; 60 and 400-Hz electrical power sources and cable runs; firelanes; and specific clearance requirements [Ref 19]. When developing a site plan, each individual type, design, and version of the MF must be considered (See Appendix E). Certain styles of MF need to be employed at different times [Ref 19].

When disjoining a MF complex, consider special requirements for MFSO styles, availability of adequate space for MHE and personnel, and electrical load requirements of both individual and complexed system MFs [Ref 19]. A well-conceived site plan is essential to the installation

process and efficient operation of the units after installation. Chapter 2 of the AG-360MF-IIN-000 should be utilized when developing any preliminary site plan, performing a site survey, and finalizing a site plan.

1. Pad Construction

The pads upon which MFs are to be complexed may range from compacted earth to a full-fledged reinforced concrete aircraft parking apron [Ref 19]. Many factors, including the duration of the MF complexing, severity of the seasons at the location, and assigned mission all effect the type of pad selected for a proposed MF complex. Although MFs are designed to be placed on almost any surface, they need a hardened surface of some sort. The EA-6B EMMMF complex at Aviano Air Base, Italy was on rock and made for a dusty and muddy situation and was hazardous to equipment [Ref 23]. Asphalt was laid in Prince Sultan Air Base in Saudi Arabia to reduce some of the dust and contaminates that would migrate into the spaces [Ref 23]. For the proposed system, and the location of the MFs at ashore AIMDs, the concrete pad option is the best choice. Reinforced concrete is the ideal pad site for a MF complex, with an integral pad site and an integrated electrical grounding system (more on this later). Also, some type of security perimeter needs to be established around the MFs. [Ref 3][Ref 19].

The pad should also have underground utilities and electrical power distribution, and MF tiedowns. This type of surface is optimal and the best choice for the proposed system. This pad type would provide the most stable surface, minimize effects of dirt and dust within MF complexes, and provide protection for utilities and electrical power distribution cables [Ref 24]. Underground utility distribution provides protection from vehicles, SE and personnel and is a normal procedure for long term MF installation on a van pad.

In July 1993, the Base Realignment and Closure (BRAC) commission recommended that El Toro Marine Corps Air Station (MCAS) undergo closure and that its aircraft, along with the dedicated personnel that support and maintain the a/c be transferred to Miramar NAS (later renamed Miramar MCAS). When several of the MALS were relocated to Miramar, numerous van pads needed to be built to support the Marine fixed wing and rotary aircraft. It cost approximately $900,000 per pad in 1998 to design, construct and build a pad and the associated infrastructure [Ref 24]. The pad included underground utilities, grounding capability, and pop-up electrical outlets, all on a concrete base. The infrastructure included roads for access to the site, fences for security, lighting and bathrooms.

Based on the notional mix and quantity of a/c the proposed site would need to support, the quantity of ATE/avionics and associated MF being offloaded from the CVNX, we should be able to determine how many van pads are required. Based on a 12 plan F/A-18 squadron that is supported at a MALS, there are between 35-38 MFs that would be required to provide I-level maintenance support for the avionics area (MALS 600 series work centers) for both common and peculiar based on the TBA [Ref 25]. That requirement alone would occupy one van pad, a space approximately 110 feet by 110 feet. The fire lane requirements access to public roads and distance to water access to fight fires all contribute to increasing the overall van pad footprint. The next section will discuss how too complex the MFs

2. Complexing

Prior to setting up the proposed systems MF complex, a final complex site plan shall be completed and approved. Complexing, or joining two or more MFs into a functional entity, enlarges the entire scope of the MF program [Ref 4]. Each complex is limited to 41 MFs, including

stacked units due to the limit of six Integration Units (INUS) per system and fire code restrictions. The capability of complexing allows maintenance workers to integrate several work functions into one environmentally controlled space. Ensure when transporting MFs, the sequence priority in which they will be shipped and employed is considered when a MF complex is established [Ref 19]. The complexing of MFs is normally accomplished by using a combination of the various types of MFs based on customer requirements and the Table of Basic Allowances (TBA)[Ref 19].

The TBA lists configurations and numbers of MFs required to give intermediate level (I-Level) maintenance support capability for deployed aircraft. This document is the MF allowance list for the entire Marine Corps. It lists all MF associated major/minor ancillary equipment. The allowances for the USMC MF equipment items are in the TBA, NAVICP 00-35T-37-4, Part 6 [Ref 19]. The allowance document for the Navy MFs is the mobile facility page of the Weapons System Planning Document (WSPD). The TBA is organized around a different notional mix of a/c then what is embarked aboard CVNX. The Navy has a different inventory of a/c, different T/M/S and different SE requirements than the Marine Corps.

NADEP North Island is drafting a preliminary instruction that describes how too complex MFs per the Marine Corps TBA [Ref 26]. This preliminary draft will produce drawings and spreadsheets that will supplement the T-AVB Logistics Planning Manual in executing the initial logistics planning of a T-AVB deployment or any tactical deployment of MFs. This instruction and accompanying Auto-CAD drawings and spreadsheets could be utilized for the proposed system for CVNX [Ref 26]. Along with each notional drawing provided by Auto-CAD, is a corresponding spreadsheet. There is a file for each different notional mixes of fixed and rotary wing MFs. The program can provide digitized

layouts of several of various notional mixes of complexed MFs per TBA and help determine where to locate the complex, based on size requirements, at the ashore AIMD [Ref 27].

The program that NADEP NI is creating could serve as a guide in the decomplexing, embarkation, and debarkation of MFs from CVNX and in complexing at the ashore site [Ref 26]. Using serial numbers off the MF, it would be possible to determine which workcenter owns the MF and equipment inside. This would shorten the time needed during the pre-loading activities and during the complexing phase of MFs shore. When moving the MFs from shore to the CVNX, once the notional mix of all a/c that will be embarked is determined, IMA personnel can compare the data and layouts provided with their assets or hand and start identifying these MFs. The program was developed with the T-AVB ship in mind, and would need to be modified for a CVNX using the Navies WSPD. Considerable time, money, and effort would be required to develop this modification, but it is possible.

After the MFs and equipment is offloaded from CVNX and transported to the ashore site where the plan is for it to be operational, additional costs are incurred as a result of the offloading and complexing at the ashore site. Electrical power needs to be arranged and funded from the ashore public works, communications and plumbing as well. Also, as discussed previously, the correct MHE gear needs to be on-site and ready, along with trained personnel knowledgeable on complexing MFs together.

3. Power Requirements

When determining the electrical load (expressed in kilovolt-amperes (KVA)), the estimated electrical power demand on power sources shall be calculated from the total MF maximum demand loads of individual MFs in the MF complex [Ref 19]. The preliminary draft instruction and Auto CAD system mentioned in the complexing section will be able to show the

total electrical load in KVA of each complex or group of complexed MFs at the proposed site. Power sources must provide 60 or 400Hz electrical power to meet the requirements of the ATE and be uninterruptable, regulated, and has a ship/shore transformer to accommodate the CVNX/ashore power supplies.

a. Electrical requirements tidbits

An analysis of the total electrical load in each MF results in the maximum demand load. Considerable planning must be done to include start-up requirements, working hours, CASS system and its modifications as a/c change. Some areas to consider also include, little or no variation in voltage from ashore power ("clean electricity"), optional fair sharing of phases (not maximizing one, and remaining phases are underutilized), and protection of the MF against a lightening strike [Ref 19].

When designing the "van pad," ensure all utilities are below ground, with pop-up electrical power sources as located throughout the pad. Currently van pads are designed with approximately 800 amps per pad. As technology changes and the avionics become more complex on the T/M/S of aircraft, the power requirements for the ATE will increase. A minimum of 1500-1800 amps capacity should be designed into any van pad designed to support the proposed system. It is cost prohibitive to tear up existing van pads and install new utilities and power cables to support the higher amp requirement(s).

Also, when designing the proposed MF complex, the possibility of voltage drop in the MF complex power distribution must be considered. To help reduce voltage drop, MFs housing equipment with tight voltage tolerances should be placed in the MF complex as close as possible to the power source and cable runs should be kept as short as possible [Ref 19]. The location of special, 60 and 400-Hz power sources

is also critical. Provisions for distributing 60 and 400-Hz electrical power band from a complex should be in the initial site planning stage

b. CASS specifics

One of the most important systems that will be placed in the MF when it comes ashore is CASS. The system is used as the Navy standard ATE for support of electronic systems IMAs both ashore and afloat. Eventually all ATE will be converted to some type of CASS. Currently each MF has one ECU installed. The CASS system requires good air movement and coolant air because of the quantity of heat generated by the system [Ref 28]. Because of the increased capabilities of test equipment required to test, maintain and repair various avionics equipment, a doublewide or two MFs joined together in order to accommodate the system. A minimum of four ECU's, a doublewide trailer and an additional chiller unit are required to support existing CASS systems today [Ref 28]. With each aircraft carrier now deploying with 18 CASS systems onboard, that means for the CASS system and associated stations require 36 MFs when on the ship. That is a significant concern onboard a CVNX when every inch of space is at a premium and increasing any footprint is scrutinized [Ref 22].

c. Territorial issues

The current MALS MF for the Marines AV-8 harrier jet (which has RTS, HTS, RBS) is also a doublewide, and it has a large footprint [Ref 28]. If the systems that need to be placed in the MF are not optimizing interior dimensions/volume of the MF, then it will become an issue not only onboard the ship, but also ashore. When the CASS system was placed in the MALS initially, the footprint required grew by approximately 30% [Ref 28]. The decision to place MF's and their associated SE onboard a carrier comes down to a territorial issue, how much volume does the MF and its equipment take up.

d. Electrical Grounding

Total resistance to earth is affected by: soil type, temperature, and moisture content, contact resistance between earth electrode and soil, and connector resistance [Ref 19]. The ground rod resistance is a function of the earth and soil resistance and should meet the goal of 10-ohms resistance to earth of the ground rod system. Each INU, power transfer box and MF power panel has a terminal lug, which can be connected, to earth ground. The fall-of-potential test needs to be performed on the proposed system site prior to power (commercial) being turned on. It is recommended in the proposed system we include an integral grounding system during MF pad construction. The safety of personnel and high dollar equipment depends on proper electrical grounding.

G. COMMON/PECULIAR

In order to understand the TBA, one must first understand the MALSP concept. The MALSP is the cornerstone of the Marine logistics support strategy. The MALS have unique requirements associated with the CASS program. Different types of CASS mobile facilities deliveries are made to fixed and rotary wing MALS. The CCSP and PCSP were discussed previously in Chapter II and how it applies to the MALSP. The CCSP supports F/A 18's, MV-22, AV-8B and EA-6B aircraft for a notional air wing of all fixed or common rotary wing types [Ref 6][Ref 8]. CCSP's receive CASS plus all common Test Program Set's (TPS's). The PCSP contains peculiar support equipment, which includes peculiar CASS TPSs. The CCSPs require station quantities and configurations based on the Air Combat Element (ACE) workload, not just the types and quantities of aircraft at the specific MALS. Common TPSs are delivered to each CCSP, while platform-peculiar TPS's are delivered to appropriate PCSPs. CASS stations are not included in a PCSP, but are delivered to CCSPs and the

Follow-on Support Package (FOSP), which we will not discuss in this paper.

For example, squadrons under an airwing differ in their SE allotments, some with common SE and others with peculiar. The issue in the proposed system is we have different squadrons, geographically dispersed but with common SE and one squadron will be required to bring all the common SE for the CVNX airwing. That squadron, the ACE unit, is responsible for bringing on deployment all the common gear for his airwing [Ref 25]. That designation will have to be made by either CVW, TYCOM or NAVAIR. That designation needs to be early, prior to the ship and airwing entering IDTC. The other squadrons will bring only the peculiar support for their T/M/S of aircraft. Strict accountability must be maintained not only for ownership, but also to ensure the right mix of ATE, at the right quantity, and in the right configuration is delivered to the proposed site location and AIMD on CVNX when required. This area requires more research than the author has time for. This is a significant drawback to the proposed system and requires further research.

H. MANNING ISSUES

By placing the MF ashore during ship availability periods, the sharing of aviation functionality among the carrier fleet reduces acquisition cost, and thereby reduces the permanently-embarked crew size necessary for the shipboard maintenance of these spaces, and results in reduced life cycle costs [Ref 7]. If the carriers (NAVAIR and TYCOM guidance) share the offloaded MFs, then the remaining shipboard personnel would maintain a "caretaker," or office presence, there to maintain interfaces, and keep up the systems that could not be containerized. The previously assigned ship's company AIMD workcenter have been "modularized" could then be assigned ashore to the SEAOPDET's and work/train with the MF systems ashore in the proposed

system. Another alternative is for the MFs to be crossdecked from one aircraft carrier to another (non-operational shipyard type to a vessel that is in the IDTC pipeline or on deployment). This will be discussed further in Chapter IV.

Shore-basing the avionics area of the carrier AIMD in the proposed system would cause many changes in the billeted ship structure and AIMD ashore and change the AMD (See appendix H), SMD, SQMD, and SOD. In the proposed system, the majority of IM-3 personnel would transfer to the NAS AIMD and become part of the SEAOPDET. The offload of MF s impacts SEAOPDET to the extent that the ATE maintainers now would have to accompany the MFs, vice remaining part of ships company. Carrier manning would decrease, and billets would be added to the SOD to compensate for the movement of the benches. Essentially, ship's company is being used to increase the size of the SEAOPDET.

The offloaded of MFs and associated ECU's would need to be maintained while ashore. There are two types of preventative maintenance (PM), 1) The MF shell on a 13-week PM schedule, 2) The ECU on a 13/26-week PM schedule. This will require additional AS's, who would be responsible for the upkeep and maintenance on the ashore MF and ECU. The costs associated with maintaining the MF will be addressed in the next chapter.

Another factor to be considered is that certain logistics personnel may need to transfer ashore under this proposed system. Assuming a significant portion of IM-3 Avionics Division goes ashore temporarily while the CVNX is in a long availability period and between deployments, a portion of the storekeepers now stationed aboard ship may have to transfer with them as well.

I. SUMMARY

The concept of MFs on CVNX is geared to improving logistics and reducing both procurement and life cycle costs. Life cycle costs can be reduced through less manpower intensive loading and unloading of supplies, components, and systems. Also, upgrades to spaces can be performed in controlled factory environments ashore, not at the pier. To incorporate MFs and then their use ashore when the ship is in its availability period will require buy-in from all parties, including the maintenance community, ship program, TYCOM's, shipyard, NAVSEA, NAVAIR, and OPNAV.

An all encompassing program similar to the MALSP should be developed by the Navy to enable aviation logisticians, maintainers, engineers, and support personnel to integrate the proper personnel, SE, and MF to properly provide I-level maintenance to any given number of a/c. Such a program would benefit the Navy by providing the ability to tailor and phase logistical support, reduce embarkation and debarkation footprint, and improve employment of assets.

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IV. ANALYSIS OF PROPOSED SYSTEM

Considering maintenance upkeep, yard periods, inport and local operations, less than 25% of a aircraft carrier's 50-year life span is actually spent forward deployed, on-station [Ref 16]. As discussed in Chapter III, the CVN/CVNX availability period (a portion of the remaining 75 percent mentioned above), is the optimum time to utilize the proposed system, and move the avionic MFs ashore to the selected NAS AIMD. We previously discussed the size of a MALS MF complex required to support a 12-plane F/A-18 squadron. Between 35-38 MFs are necessary to provide the proper I-level maintenance support for the avionics area (MALS 600 series equivalent work centers) for F/A-18s alone [Ref 25]. That requirement would occupy one van pad, a space approximately 110 feet by 110 feet. If that same 12-plane squadron of F/A-18s was designated the ACE for the airwing, that squadron would be tasked with deploying with over 250 MFs (common) to support <u>all</u> areas of AIMD (not just avionics) [Ref 25].

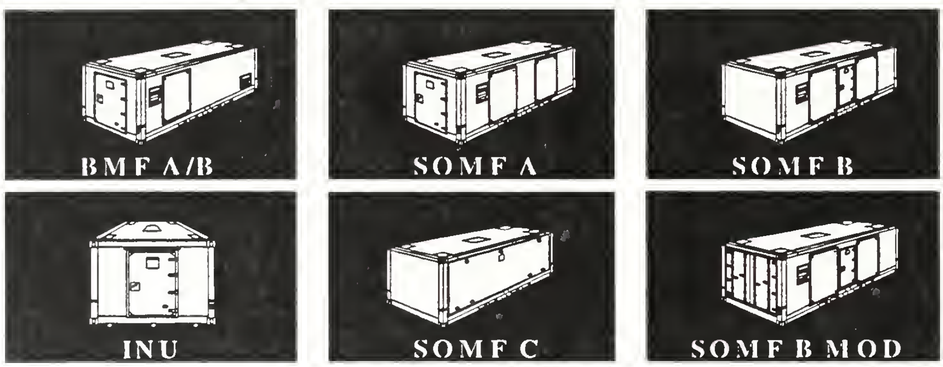
A CVNX-class carrier will likely deploy with three F/A-18 squadrons, common support aircraft (S-3, E-2, EA-6B), one SH-60 squadron and an unknown quantity of JSF onboard when she is tasked with her first deployment in 2015. We could determine the quantity of MFs required to support the avionics area by reviewing the WSPD, the Navy equivalent to the MALS TBA. However, in 20 years when the proposed system would be implemented, a/c will change requirements and SE will change, and the current WSPD and TBA will not apply. An aircraft carrier in its 50 plus year life span will have approximately 2-4 generations of a/c operating from it.

For this analysis, we will assume that 100 MFs are onboard the aircraft carrier, and will be removed to the proposed site when the ship enters an availability period. This number was determined by footprint

availability, phone calls to various NADEP NI engineers, dialogue with F/A-18 Marine units and a previous discussion with the sponsor for this research. Also, Nichols Marine and Newport News Shipbuilding (NNS) undertook a study to ascertain the quantity of MFs a Nimitz-class aircraft carrier could accommodate, the first contractor determined 80 MFs would fit on an existing Nimitz-class ship, NNS was able to fit 120 MFs [Ref 22]. The average of the two studies was also 100MFs. For the remainder of this Chapter, we will base our analysis on 100 MFs for the proposed system.

A. COSTS OF CURRENT MOBILE FACILITIES

As mentioned in Chapter II, the basic design of the MF currently used in the DoD inventory for aviation maintenance is an 8 feet high, by 8 feet wide and 20 feet long, foam and beam, rigid ISO container [Ref 3]. The design of the current MF in use is based on 1975 technology, with variations to the basic model as customer requirements changed (see Appendix E). The current costs of MFs are provided in Table IV-1.



<u>1998 Contract Prices</u>

BMF A	**$34,905**	**BMF B**	**$37,390**
SOMF A	**$34,415**	**SOMF B**	**$35,500**
INU	**$35,115**	**SOMF C**	**$35,100**

average price (w/o INU) $ 35,462

Table IV-1 Cost of MFs

If we utilize the average cost of the various types of MF, then for the Type A, B, and C models above, the initial cost of procuring sufficient MFs for one aircraft carrier and the proposed site that goes with the ship, the is approximately $3.55 million. The INUs are required at the ashore site only [Ref 4]. Assuming we will set the MF complex up at the NAS AIMD, which was previously discussed as geographically dispersed on the east and west coast, we will require six INUs per 41 complexed MFs. It is estimated we will need 15 INUs per proposed system of 100 MFs to support the complexing of the units because of the NAS AIMD locations in a variety of states. The cost of the INUs would then bring the total cost of the MFs and INUs for the ashore site to approximately $4.08 million, per aircraft carrier.

These costs are based on procuring the shell of the MF/INU prior to configuration by PWC Norfolk or NADEP NI, as determined by customer requirements. The shell itself is void and without form. Only doors and panels are installed. There are no lights, raceways, ECUs, power plants, etc [Ref 5]. MFs are internally configured and outfitted for a specific function, e.g. peculiar support for EA-6B, F/A-18 peculiar avionics systems, or general/maintenance functions in support of common systems, such as micro miniature repair, common avionics, etc. [Ref 3]. Once configured, the unit will have the before mentioned items plus, MF property, ECU's, IMRL, SE installed, or other items as the user requires

The following example illustrates this point. MALS-31 TBA currently has over 400 MFs on hand, under 130 different configurations for one type model aircraft [Ref 12]. Estimated costs for configuration of a MF can range from $8,000 for a simple office style, to over $75,000 for a hydraulic workstation MF [Ref 5]. For this analysis, we will assume avionics specific MFs and use an average cost of $40,000 per MF. If the proposed system has 100 MFs, the average cost for configuration is $4 million. As the estimate indicates, there are significant costs involved

with the configuration of MFs associated with the amount of ATE and I-level support required [Ref 26].

It may not be possible to obtain a good configuration estimate for a proposed system that is 20 years in the future. The a/c that the I/level maintainers have to support are still unknown (JSF, replacement for or latest T/M/S of the common support a/c, and the latest T/M/S of F/A-18), and the status of the ATE at this time undetermined. The author used an average configuration cost based on existing technologies, and the cost that NADEP NI had available for the MFs they presently configure for the MALS. This is a significant cost driver that needs further research.

B. OTHER DEPARTMENT OF DEFENSE TYPES OF MOBILE FACILITIES

The U.S. Army (USA) employs lightweight, highly mobile shelters designed by Marion Composites. The Army Standard Family of Shelters (ASF) is constructed of aluminum-faced, non-metallic honeycomb sandwich panels, meeting the ISO cargo container specification [Ref 29]. The Army currently has a modular relocatable hospital that allows users to integrate the units they desire in a variety of complex plans to meet their specific needs.

The U.S Air Force (USAF) Shelter Technology (SHELTECH) is the services focal point for tactical shelters and shelter accessories [Ref 30]. The Avionics Intermediate Shop Mobile Facility (AIMSF) is a deployable, tactical shelter system designed to “house” automated test stations of avionics intermediate maintenance shops in support of the F-15 and F-16 aircraft. The primary design of these shelters is to reduce the footprint required to deploy, while still providing an integrated shelter/ECU system sufficient to adequately support the aircraft intermediate maintenance facility.

The proposed system should look at available technology and consider other versions of the MFs currently available in the commercial marketplace, but still meet ISO and ANSI requirements. The use of dissimilar metal combinations shall be avoided whenever possible. With the advent of composites, corrosive-inhibiting paints and compounds, and durable materials, we should look at alternative structures to house our expensive ATE gear than the current 1975 technology MF that is serving the fleet today. The costs of maintenance and the manning requirements utilized on the existing MFP are high under the present system and will be addressed later in this chapter.

C. TRANSPORTATION COSTS

The MFs need to be properly positioned on the ship for offload so that the MFs designated for the same NAS AIMD site are all offloaded at the same time. Prestaging the MF in the hangar bay is critical to making this a viable plan. That also applies to unloading the MF as well. The MF should be unloaded so that they may be sequentially inserted in the avionics area of the ship AIMD and not cluttering the hangar bay.

Transportation is an essential element of this proposed system and are necessary for transferring MF and their equipment to/from the ship and the ashore site. The cost per carrier to offload the MF and its equipment is based on the crane crew costs; cost to rent an air ride tractor-trailer and rental cost of a 20 K forklift (required at ashore AIMD site to offload MF). Transportation costs for all fleet directed MF movements must be borne by the appropriate major claimant (TYCOM). The following costs relate to establishing a dedicated transportation channel from the carrier homeport to the designated NAS ashore facility where the MFs will be moved.

1. Crane costs

It is estimated that it will take 15 minutes to cycle a crane with the MF [Ref 31]. Crane cycle time is defined as the time required to, rig the MF, lift and place the MF onto surface transportation ashore, and be ready for the next MF lift. Based on 100 MFs for this system, and an eight-hour day it will take just over three days to offload all the MFs. That is with a dedicated crane, specifically designated to offload MFs only. For the basis of this analysis, we will assume three days on average to offload the MFs, and that set up time for the crane prior to offloading the MFs are not included in the eight-hour day. We will also assume that all offloading occurs at a U.S. Naval Station, not at a shipyard where the crane crews costs would be significantly higher. As you can determine by the time involved in offloading the MFs, the crane cycle time is a critical point in the off load productivity of this proposed system.

An assumption is made that the Naval Station Public Works organization has a spreader bar to lift the MF; all those contacted stated they had available assets. Care must be taken during the offload so that the installed equipment and MF do not become damaged during the move ashore and/or back to the carrier.

2. Forklift costs

The analysis will use the rental rates, and any additional operator costs of the forklifts at the carriers homeport. The proposed ashore site may determine that is more advantageous to procure their own forklift, but they need to realize that all the life cycle cost (maintenance, oils, training, repair, etc) need to be factored in to that decision. For simplicity, the analysis assumes that the forklift is rented locally. The cost of a sample forklift that could possibly be used for the proposed ashore site may be found in Chapter II.

3. Tractor trailer costs

The tractor-trailer that is utilized to transport the MF, both locally and long distance, must be an air-ride vehicle to protect the sensitive gear in the MF as previously discussed in Chapter II. It is assumed that if air ride assets are not available, that the public works department will locally contract out for the trailers at the same rate as public works charges. The rates in Table IV-2 through IV-6 below differ from one Naval Station to another, based on operator costs and per diem. All the prices provided are roundtrip rates, and include fuel, oil and miscellaneous expenses unless otherwise noted. The flatbed portion of the trailer is 40 feet long, so two MFs destined for the same location may be placed on each trailer.

The critical factor in the tractor-trailer costs is the cycle time necessary for the flow of MFs between the carrier homeport and the proposed site for the MFs at the NAS AIMD for the T/M/S of aircraft. The cycle time is dependent on the distance traveled and the time to on-load and off-load the MFs. For simplicity, other variables such as weather and road conditions, traffic, or availability of transportation assets were not included in the assumptions. The volume of MFs required to be moved will determine the quantity of tractor-trailers to rent. The expense associated with this area in the proposed system far exceeds the crane crews and forklift combined.

4. Assumptions

Since the MF can not be removed until after the 30-day post deployment standown, and the aircraft carriers surge status removed, we have assumed that all MF will be offloaded in their homeport vice another Naval port. Commercial ports were not considered, although they may shorten the logistic transportation costs, the port services charged to the ship would far outweigh any cost benefits that transportation savings would provide at a non-Naval site. Suggestions on which Naval port that

the air ride tractor trailer should be rented from, based on total costs and assets available, will be provided on each coast.

The costs described below in Tables IV-2 through IV-6 use straight time labor and assume that overtime is not utilized. If not, the costs of a spreader bar would need to be added. A vehicle and driver for the tractor trailer and crane crew (operator and riggers) are necessary elements in the offloading and transporting of the MF and equipment in the proposed system. All numbers in the below tables are rounded to the nearest dollar, estimated costs are in FY 2000 dollars.

A mathematical optimization model should be developed to determine the ideal location to offload the MFs, the priority of offloading the MF based on their destinations, and the critical path the MF shall follow to cut costs. The model is beyond the scope of this thesis, but may be useful to determine the most cost-effective plan to load and offload. Also, a modification of the T-AVB Automated Load Planning System (TALPS) utilized by the Marines, may be beneficial to the Navy to accomplish the offload and load planning.

5. East and West coast location costs

a. Norfolk, Virginia costs

There are presently five aircraft carriers stationed in Norfolk, VA. As mentioned in Chapter III, the MF would need to be transported to a variety of sites based on the location of the NAS AIMD and hence the location of the proposed MF sites. The Norfolk transportation costs were determined by utilizing the rates in Table IV-2. These rates were determined by placing calls to the Norfolk Naval Station Public Works Center (PWC) [Ref 31][Ref 32].

LOCATION: NORFOLK, VIRGINIA	
Crane and Rigging	**Price**
Crane Rental, (one price/per hour)	126.00
Forklift	
20 K forklift, rental including operator (one hour)	47.00
Tractor-trailer, hourly rate (air ride unless annotated)	46.00
Authorized drive 12 hrs/day, if stop per diem at location extra	
Note: Crane includes operator and two riggers	

Table IV-2 Norfolk transportation costs

The cost for the offload of all MFs by the crane crews would total $378. Local tractor-trailer rates would apply to the MFs assigned to the F/A-18 and E-2 squadrons. Estimating that 75% of the MFs would be in a proposed system in the Tidewater area, and it would take three days to accomplish the offload, utilizing two air ride trucks, the total tractor trailer cost comes to $3312. The rental for two (2), 20K forklifts for use at the proposed ashore site for five days; three days to take the MFs off the trailer, another two days to move the MFs around to complex them together at the ashore site totals $3760. Approximately 20 MFs will be sent to Jacksonville, FL for the S-3 and SH-60 squadrons. That equates to 5 tractor-trailers (two per trailer), four day overall trip duration (two on the road, two at the Florida site offloading) for a total of $10,800 (not including per diem). With an estimated per diem at $75.00/day, this would add an additional $1125 to the truck expense. The remaining 5 MFs will be shipped to Whidbey Island; presently the cost to ship the EA-6B vans to Whidbey NAS from Norfolk is over $20,000[Ref 32].

The total bill for the Norfolk area is approximately $40,000 for offloading the MF and taking it the ashore site. Adding in the eventual onload of the MF once the ship departs the availability, the total cost is over $80,000. This is the least expensive of all of the aircraft carrier homeports in this analysis. The costs will be slightly higher if one of the CVW F/A-18 squadrons is Marine Corps, vice Navy. The applicable MFs

will then have to be shipped from Norfolk, VA to Beaufort, SC. Those costs were not obtained for this analysis.

b. Jacksonville, Florida costs

There is presently one aircraft carrier stationed in Mayport, FL. The Jacksonville/Mayport transportation costs were determined by utilizing the rates in Table IV-3. These rates were determined by placing calls to the Mayport Naval Station PWC [Ref 33][Ref 34]. It should be noted that the CV presently in Mayport is scheduled to retire in 2018. The analysis assumes it will be replaced by another aircraft carrier at that time.

LOCATION: JACKSONVILLE, FLORIDA	
Crane and Rigging	**Price**
Crane Rental, (one price/per hour)	150.00
Forklift	
20 K forklift, rental including operator (one hour)	50.00
Tractor-trailer, hourly rate (air ride unless annotated) 56.00 Authorized drive 8 hrs/day, if stop per diem at location extra	
Note: Crane includes operator and two riggers	

Table IV-3 Jacksonville/Mayport transportation costs

The cost for the offload of all MFs by the crane crews would total $450. Local tractor-trailer rates would apply to the MFs assigned to the S-3 and SH-60 squadrons. Estimating that 20 of the MFs would be in a proposed system in the Jacksonville/Mayport area, and prioritizing the local MF moves to one day, utilizing two air-ride trucks, the total tractor trailer cost comes to $896. The rental for one (1), 20K forklift for use at the proposed ashore site for three days; one day to take the MF off the trailer, another two days to move the MF around to complex them together at the ashore site totals $1200. Approximately 75 MFs will be sent to Norfolk, VA, for the F/A-18 and E-2 squadrons. That equates to 38 tractor-trailers (two per trailer), a four day overall trip duration (two on

the road, two at site offloading) for a total of $85,120 (not including per diem). With an estimated per diem at $ 75.00/day, this would add an additional $11,400 to the truck expense. Also, two forklifts are required at Norfolk/Oceana to offload the MFs and move them around for complexing for a cost of $1504. The remaining 5 MFs will be shipped to Whidbey Island, Washington. The cost to ship the EA-6B vans to Whidbey NAS from Mayport is over $25,000[Ref 34].

The total bill for the Mayport area is approximately $126,000 for offloading the MFs and taking it the ashore site. Adding in the eventual onload of the MFs once the ship departs the availability brings the total cost to over $252,000. From a transportation perspective, it appears that offloading the MF in Norfolk costs less. But the additional operational time the aircraft carrier would have underway to transit to another port to offload the material needs to be considered as well.

c. *San Diego, California costs*

There are presently two aircraft carriers stationed in San Diego, CA (North Island). As mentioned in Chapter III, the MF would need to be transported to a variety of sites based on the location of the NAS AIMD and hence the location of the proposed MF sites. The San Diego transportation costs were determined by utilizing the rates in Table IV-4. These rates were determined by placing calls to the San Diego Naval Station PWC [Ref 35][Ref 36].

LOCATION: SAN DIEGO, CALIFORNIA	
Crane and Rigging	**Price**
Crane Rental, (one price/per hour)	230.00
Forklift	
20 K forklift, must provide own operator (one hour)	10.00
Tractor-trailer, hourly rate (air ride unless annotated) 750.00 Authorized drive 12 hrs/day, includes per diem (6 trucks available)	
Note: Crane includes operator and three riggers, N. Island=San Diego	

Table IV-4 San Diego transportation costs

The cost for the offload of all MFs by the crane crews would total $690. Local tractor-trailer rates would apply to the MFs assigned to the S-3 and SH-60 squadrons. Estimating that 20 of the MFs would be in a proposed system in the San Diego area, and it would take one day to accomplish the offload, utilizing two air ride trucks, the total tractor-trailer cost comes to $1000 (no per diem). The rental for two (2), 20K forklifts for use at the proposed ashore site for three days; one day to take the MF off the trailer, another two days to move the MF around to complex them together at the ashore site totals $480 (not including operator). Approximately 10 MFs will be sent to NAS Point Mugu, CA for the E-2 squadron. That equates to five tractor-trailers (two per trailer), a four day overall trip duration (three on the road, one at site offloading) for a total of $15,000 (including per diem). There are approximately 65 MFs that support the F/A-18 squadrons that need to be transported to NAS Lemoore, CA. That equates to approximately 32 air-ride trailers, a five day overall trip duration (three on the road, two to offload) for a total cost of $120,000 including per diem). The remaining 5 MFs will be shipped to Whidbey Island, presently the cost to ship the EA-B vans to Whidbey NAS from San Diego costs over $12,000[Ref 36].

The total bill for the San Diego area is approximately $150,000 for offloading the MF and taking it the ashore site. Adding in the eventual onload of the MF once the ship departs the availability brings the total cost to over $300,000. This does not include the forklift costs associated with offloading the MF at Point Mugu, Lemoore, or Whidbey, which likely would add at least another $3,000 to the total.

d. Bremerton and Everett, Washington costs

There are presently two aircraft carriers stationed in the state of Washington (one each at Naval Stations Everett and Bremerton). As mentioned in Chapter III, the MF would need to be transported to a

variety of sites based on the location of the NAS AIMD and hence the location of the proposed MF sites. For purposes of this analysis, we will assume that Bremerton's and Everett's cost are similar, and use Table IV-5 in our analysis. This assumption is made based on the comparison of rates obtained and the geographic distance of the two bases. Costs for Bremerton are provided for information only in Table IV-6. To determine the transportation costs associated with the proposed system, the rates were obtained from the Everett and Bremerton Naval Station PWC's [Ref 37][Ref 38][Ref 39].

LOCATION: EVERETT, WASHINGTON	
Crane and Rigging	**Price**
Crane Rental, (one price/per hour)	600.00
Forklift	
20 K forklift, must provide own operator (one hour)	10.00
Tractor-trailer, hourly rate (air ride unless annotated)	25.00 Authorized drive 12 hrs/day, add $0.48/mile+ per diem
Note: Crane includes operator and four riggers	

Table IV-5 Everett transportation costs

LOCATION: BREMERTON, WASHINGTON	
Crane and Rigging	**Price**
Crane Rental, (one price/per hour)	300.00
Forklift	
20 K forklift, rental including operator (one hour)	34.00
Tractor-trailer, hourly rate (air ride unless annotated)	**N/A**
Note: PWC not authorized drive beyond 100 mile of base, Std Truck rate $40/hr	

Table IV-6 Bremerton transportation costs

To simplify the transportation cost analysis, we are using the Everett rates (Table IV-5), and assuming they are equivalent to Bremerton rates. The cost for offload of all MFs by the crane crews, for one carrier, would total $1800. Local tractor-trailer rates would apply to the MFs assigned to the EA-6B squadron. Estimating that five MFs would be in a proposed system it would require one day to accomplish the offload,

utilizing two air-ride trucks, the total tractor-trailer cost comes to $650 (no per diem). The rental for two (1), 20K forklifts for use at the proposed ashore site for one day to take the MF off the trailer and to move the MF around to complex them together, totals $80 (does not include operator). Approximately 10 MFs will be sent to NAS Point Mugu, CA for the E-2 squadron. That equates to five tractor-trailers (two per trailer), a twelve day overall trip duration (ten on the road, two at the site offloading) for a total of $25,000 (including mileage). If you estimate per diem at approximately $75.00/day, you would add an additional $4500 to the truck expense. There are approximately 65 MFs that support the F/A-18 squadrons that need to be transported to NAS Lemoore, CA. That equates to approximately 32 air-ride trailers, a ten-day overall trip duration (eight on the road, two to offload) for a total cost of $106,000 (including mileage). If you estimate per diem at approximately $75.00/day, you would add an additional $24,000 to the truck expense. The remaining five MFs will be shipped locally to Whidbey Island, a one day trip that will cost $450.

The total cost for the Everett/Bremerton area is approximately $160,000 for offloading the MFs and taking it the ashore sites. Adding in the eventual onload of the MF once the ship finishes its availability period, the total cost is over $320,000. This does not include the forklift costs associated with offloading the MF in the state of California at Point Mugu, Lemoore or North Island, which likely would add another $5,000 plus to the total. The estimated total above is very close to the number calculated for the San Diego based aircraft carrier. Based on this analysis, the author sees no benefit to offloading the West Coast based MFs at San Diego, especially when the costs of underway time is factored in as well.

D. SITE AND ANCILLARY GEAR COSTS

The price quoted earlier in the chapter was for purchase of a shell to the MF prior to configuration, without any ECU's, power panels, or other SE. The prices listed in Table IV-7 are for the SE required to sustain the MF at the proposed site ashore. Each MF requires a minimum of one ECU. For the CASS system as stated previously, they require two ECU's and an additional chiller unit. Assuming that approximately 50% of the MFs are necessary to "house CASS," then 150 ECUs are required at a total cost of approximately $1.7 million. For each MF complex unit, we shall assume each NAS AIMD has one dolly set in the proposed system, for a cost of $52,000 per site. If we assume a minimum of three sites per coast, then the dolly set requirement is approximately $156,000.

Nomenclature	NSN	Cognizant Field Activity	Price ($)
Environmental Control Unit (Unit A/E32C-45)	4120-01-442-3954	NAWCADLKE	2,180.00
Environmental Control Unit (Unit A/E32C)	4120-01-355-2854	NAWCADLKE	11,273.00
Dolly Set, Lift Transportable	2330-01-411-9601	TACOM Warren MI.	26,160.00
Spreader, Lifting	3990-01-258-2010	TACOM Warren MI.	4,472.00
Mobile Electric Power Plant	6125-00-097-8327	NAWCADLKE	65,540.00
Generator Set, Diesel 200	6115-00-133-9104	DOD-MEP	43,281.00
Generator Set, Utility 60 kw	6115-00-407-8322	DOD-MEP	3,372.00
Generator Set, Precise 60 kw	6115-00-118-1252	DOD-MEP	18,250.00
Electronic Frequency Converter	6130-01-368-5734	NAWCADLKE	13,300.00
MFP Tactical Electrical Power Distribution Set	6110-01-448-9198	NADEP NORIS	117,500.00

Table IV-7 MF ancillary gear costs

Each MF complex will receive their 60 and 400 Hz power requirements from the base which they are located. Because the utilities used by the MALS are not metered, it is difficult to determine the costs associated with providing electricity to the units. A van pad that supports 300 MFs typically runs at 1200 KVA, based on engineering estimates [Ref

40]. That figure is based on the current ATE and equipment in the MFs and would likely increase when the proposed system is implemented.

The NAS would provide the power as a service, but additional costs for panels, terminals and cables from the junction box to the MF are not included in the van pad estimate of $900,000 provided previously in Chapter II. Panels, terminals and cables and other miscellaneous SE are estimated at $35,000 per site, for a total of $90,000 for the proposed system. If back up generators are required, the price can be found in table IV-7 below. Excluding the cost of generators, the total cost of SE and ancillary gear for a 100 MF proposed system is $2 million.

The MF power interfaces at both the ashore and shipboard sites need to be common at all sites (east/west coast, all CVN's and CVNX's). Common, standard interfaces will allow the MF systems the capability to be placed on the ship late in the ship availability process, with the most up to data systems included late in the process, versus buying outdated systems and ripping these out shortly after installation.

E. CASS IMPACT

The next generation of CASS stations will be "microsized" so the system occupies a smaller footprint. Some of the current CASS systems require a doublewide MF, and four ECUs for cooling. Microsizing CASS will be a major benefit, especially to the footprint size [Ref 28]. Replacement of the older versions of CASS stations will begin in 2006 due to obsolesce of commercial off the shelf (COTS) versions, physical deterioration, and escalating costs [Ref 8].

The next generation of Automated Test System (ATS) for DoD is called Next Test (or NxTest), and will utilize innovative maturing testing technology and open systems architecture. The system will use test functions vice-stand alone test instruments and virtual instrument software, which will both contribute to reducing the amount of hardware

[Ref 8]. This will also mean reduced acquisition costs, greater reliability and maintainability, and ease of upgrading. Also, the NxTest will require less real estate and will not require as much footprint/space in the MF as existing systems, a key selling point in terms of a shipboard or ashore environment where space is a premium.

Another separate and distinct configuration of the CASS subsystem is Reconfigurable Transportable CASS (RT-CASS). Although it is presently being developed for the V-22 program, it also has applications to other legacy aircraft [Ref 8]. The Spanish government is involved in a cooperative agreement with NAVAIR that will provide RT-CASS support to F/A-18s and SH-60s that they have purchased. If this is successful, not only will the MALS be able to support their a/c this way, but perhaps the Navy could as well. From a capabilities standpoint, the RT-CASS system may be configured for testing requiring only five to nine crates (one crate is 16 inches by 22 inches wide by 30 inches high). The RF configuration, nine crates, is nearly equal to a CASS RF station at over five times the RT-CASS size. The footprint could be dramatically shrunk, and the use of MFs would not be beneficial for a system so easily transportable, with each crate weighing less than 150 lbs.

F. MAINTENANCE RESPONSIBILITIES AND COSTS

The maintenance concept for the MFs is based on scheduled and unscheduled maintenance. The costs associated with maintenance will increase as the MFs age and the more you they are transported or moved [Ref 41]. The maintenance concept includes inspection, adjustment, corrosion control, repair or replacement of worn malfunctioning components/assemblies in accordance with the approved Technical Manuals (TMs) and the NAMP, OPNAVINST 4790.2(series). User AIMD and MALS activities are responsible for the overall maintenance and readiness of the MFs and all related SE.

1. Responsibilities

Specific action need to be accomplished on the part of the MF user to maintain the containers and related equipment. Work would have to be performed on these MFs to include: preventative maintenance, structural repair, and painting. MFs and related equipment, in use or in storage, both need to be maintained to a complete set of operational readiness. I-level maintenance of MFP equipment used in the support of a/c and weapons systems maintenance is the responsibility of the supporting AIMD or MALS in the current system [Ref 3]. The MALS have assigned the 990 workcenter, under the AO, the responsibility to carry out the appropriate levels of maintenance required [Ref 12]. In the proposed system, maintenance on the MF when ashore is the responsibility of the NAS AIMD and the CVNX AIMD avionics personnel that augment the SEAOPDET.

2. Costs

Air station AIMDs and the Aviation Support Divisions (ASD) work hand-in-hand to provide support to tenant aircraft squadrons. The ASD, or supply department, is responsible for providing the material support required to perform I-level maintenance and repair [Ref 2]. This includes materials to maintain AIMD equipment as well as the parts and consumables needed in the repair and maintenance of aircraft components and equipment.

The NAMP, 4790.2 series authorizes the use of Aviation Fleet Maintenance (AFM) funds for organizational and intermediate level maintenance of MF equipment used in support of a/c maintenance. The NASs receive their funding to operate their ASD and AIMD from the AFM and Aviation Depot Level Repairable (AVDLR) budgets supplied to them by the TYCOMS [Ref 2]. Therefore the ashore AIMD will require additional funding from the TYCOM to accomplish this new mission. The

TYCOM needs to budget and plan accordingly for this change under the proposed system.

3. Maintenance concerns

Saltwater corrosion of the MFs while onboard the aircraft carrier is a significant concern. The hangar bay elevator doors are often left open to allow light and air to enter the hangar, and to allow speed and ease of movement of a/c while underway. Saltwater and moist-laden air will therefore rapidly corrode the MFs and their support structures. This adds to an already intensive maintenance schedule, and corrosion-resistant products should be pursued to lesson the time and money expended on corrosive maintenance.

Also, the MF is subject to periodic inspections on a 91-day cycle. The maintenance requirements may be found in NAVAIR 19-25-177 Maintenance Manual. Other areas of maintenance that are common for the MFP include ECU servicing, electrical systems checks, lighting, input/transfer cable inspection and maintenance, overall visual inspections for surface damage, and lubrication of hinges. There is also normally a local requirement to wash the MF every 30 days.

The costs associated with maintenance increase as the age of the MF increases. Also, the more exposure to corrosive moisture (saltwater), the more maintenance is required. The MALS on average expend $3000 annually on the upkeep of each individual MF. The annual cost if applied to the proposed system would be $300,000. However, that is likely not accurate since the environment and movement of the proposed system/ship AIMD is significantly different than how a MALS operates.

G. MANNING IMPACT

In the proposed system, the shipboard avionics area of the carrier's AIMD would transfer ashore with the MFs and benches, to the NAS AIMD site for their respective T/M/S aircraft and become a part of the

SEAOPDET. Also, Aviation Support Equipment Technicians (AS rating) would transfer ashore to conduct the maintenance on the SE of the proposed site. The personnel would be re-assigned to the NAS AIMD that operated the a/c and equipment in which they are specialized. Workload at the proposed ashore site could be shared between the MFs and the existing shore AIMD, creating many efficiencies.

The analysis of the manpower required to support the proposed system was based on the USS J.C. Stennis (CVN-74) AMD, which can be found in Appendix H. From this document, a sample of the paygrade of avionics personnel and AS's affected by the proposed system were obtained, see Table IV-8. Using the CVN-74 AMD, it is estimated a total of 80 enlisted IM-3 sailors would be required to support all of the avionics ATE, the 100 MFs and any other functions required ashore for the proposed system.

PAYGRADE	NUMBER	AVG TIME IN SERVICE (yrs)
E-8	2	14
E-7	5	10
E-6	15	7
E-5	30	4
E-4	12	2.5
E-3 and below	16	1-2.5

Table IV-8 Paygrade, quantity and time in service

1. Manning Documents

The Aviation Manpower Requirements Determination Program for Squadron Manpower Documents (SQMD) will have to be adjusted to support the proposed system. The SQMD includes CVWs, SEAOPDET Manpower documents, and afloat AIMDs [Ref 11]. The SEAOPDET in the new proposed system, would make up a larger percentage of the I-level repair capability than it does today. Also, the SEAOPDET manpower

document, which is based on the ship's test bench and SE configuration and a/c attached, will also require modifications. Significant billet savings would not be realized until multiple carriers have modular, MF capability.

The key impact of implementing the MF concept would be an increase in the size of the SEAOPDET component, with ships company personnel being drastically reduced in the avionics area. The question now becomes: do you need a full AIMD IM-3 for each carrier or could you survive with the existing SEAOPDET philosophy where nine Detachments support all 12 aircraft carrier requirements? The proposed system will create an organization similar to the MALS where the I-level support package would be tailored to fit the airwing and deploy only when the airwing deployed. This will be addressed later in Chapter IV under the crossdeck area.

The remainder of the shipboard AIMD personnel would stay onboard the aircraft carrier to maintain equipment and spaces. Under this proposed system, only the IM-3 division officer and assistant are potential officer candidates to go ashore when the MF is offloaded. The AIMD Maintenance Officer (MO), Assistant Maintenance Officer, Material Maintenance Control Officer (MMCO), and the IM-2, IM-4 Division Officers remain on the carrier.

2. Pay and Allowances

Not only will modifications to the billeting structure occur, but also changes will happen to the payment and allowances to which personnel are entitled. Basic pay and Basic Housing Allowance (BHA) are excluded from the analysis, as they would be the same for both the proposed system and the present one

a. Sea Pay

The personnel would no longer be part of ship's company, so they would not be entitled to sea duty pay if permanently assigned to the SEAOPDET. Sea pay is an allowance that a sailor receives in addition to his/her regular pay while serving in a sea duty status [Ref 42]. The pay is designed to compensate eligible members for serving many years of arduous shipboard sea duty throughout a career. Sea pay is gradually raised as the amount of time a sailor has been on sea duty increases during his/her naval career. It is payable to enlisted members in pay grades E-4 through E-9, warrant officers and officers who have accumulated more than three years of cumulative sea duty [Ref 42]. For the analysis, the average time in service for paygrades E-4 through E-9 was estimated based on information provided from the Bureau of Naval Personnel (BUPERS). The sea pay entitlement for officers was not considered in the analysis since the proposed system will likely only have one O-3 as the Officer in charge from the ship's company. Also, E-3 and below were not counted in the total sea pay calculation since these personnel are not entitled to sea pay.

Career sea pay is paid on a monthly basis to eligible members when they are assigned to ships. Using the figures provided in table IV-8, the 80 enlisted members in the proposed system would lose a total of $14,740 in sea pay, per month, when they go ashore.

b. Basic Allowance for Subsistence

The basic allowance for subsistence (BAS) will also be affected. Enlisted members receive a monthly BAS allowance whenever subsistence in kind is not available or use of a government mess is determined as impractical, or they are authorized to mess separately [Ref 42]. BAS has three different possible incremental rates; the one that applies to this scenario is Rations Separation, or RATSSEP.

The complexities of enlisted BAS entitlements span both the spectrum of married vs. single member, and shore duty vs. sea duty issues. While stationed onboard the aircraft carrier, BAS is not paid to enlisted members assigned to shipboard duty [Ref 42]. When assigned to shore duty, both married enlisted members and senior enlisted in pay grades E-7 through E-9 are entitled to RATSSEP. BAS is intended to compensate the military member for monthly food costs, not the military family.

Using the RATSSEP rate of $7.50 per day for enlisted service members, and assuming 80 percent entitlement (married or paygrade requirements met) the total cost the members are entitled to on a monthly basis is $14,400. This amount is close to the sea pay that members lose, but the RATSSEP do not separate out paygrades. Under the proposed system, the more senior the member, the more money lost. For example, assume you are one of the E-7's. You are normally are entitled to $400 per month for sea pay. When assigned ashore to the proposed site, you earn a RATSSEP of $225 per month but you no longer receive sea pay sea pay, a loss of $175 per month. As a junior married sailor you benefit from the proposed system. Any E-1 to E-4 over 4 months (assumed all apply to length limitation) entitled to RATSSEP earns $225 per month. Previously, the same junior sailor was not entitled to any sea pay while part of the ship's company. The proposed system benefits junior RATSSEP eligible sailors, and penalizes the more senior enlisted.

3. Training

Training would also benefit from this proposal. The avionics technicians that are now ashore under the proposed system would be exposed to the ATE and T/M/S components on a daily basis, vice assigned to the ship with no a/c onboard during the availability period. The personnel assigned to the proposed system ashore would be able to keep

their skills level up, remain proficient on the ATS and decrease the learning curve effect when they return to the aircraft carrier because they have already been working on the gear.

H. ALTERNATIVES TO PROPOSED SYSTEM

The Navy's newest addition to the Nimitz-class aircraft carrier, USS H.S. Truman (CVN-75), was constructed with the EA-6B avionics areas as a permanent workspace on the ship, vice hanging the MFs/Vans as discussed in Chapter II. One reason for the change is the amount of maintenance time involved in working on the vans and overhead mounts [Ref 43]. It was very labor intensive to lower the vans from the overhead for inspections and to conduct maintenance [Ref 43]. The workspace on CVN-75 is in the same location as the vans are on other Nimitz-class aircraft carriers. Another problem associated with the existing Vans to support the EA-6B while on a carrier is that none of the services in the MF/Van are "plug and play." All electrical communication services are hardwired and the ventilation ducting is screwed in place [Ref 43].

1. Cover and platform alternative

The senior naval architect for CVNX developed many varieties of design concepts for shipboard modularization [Ref 44]. An alternative concept to the proposed system this paper has discussed is briefly explained below. (See Figure 11).

A two deck-high hangar is one alternative envisioned for CVNX. In the forward end of the hangar bay there would be a drop to one deck height and 50 modular platforms could be suspended from the gallery deck [Ref 44]. The location is in an area generally reserved for yellow gear on a carrier. Each platform is the same dimension as the current MF and acts as a base for false decking upon which cabinets, workstations, etc are mounted [Ref 44]. Each "module" comes with a shipping cover, that when attached reflects a standard 20'x8'x8' shipping container. The

cover (lids) are removed and moved under the 01 level at which point lifting devices are lowered form the overhead, attached to the corner posts of each platform and hoisted to the top of the hangar bay [Ref 44].

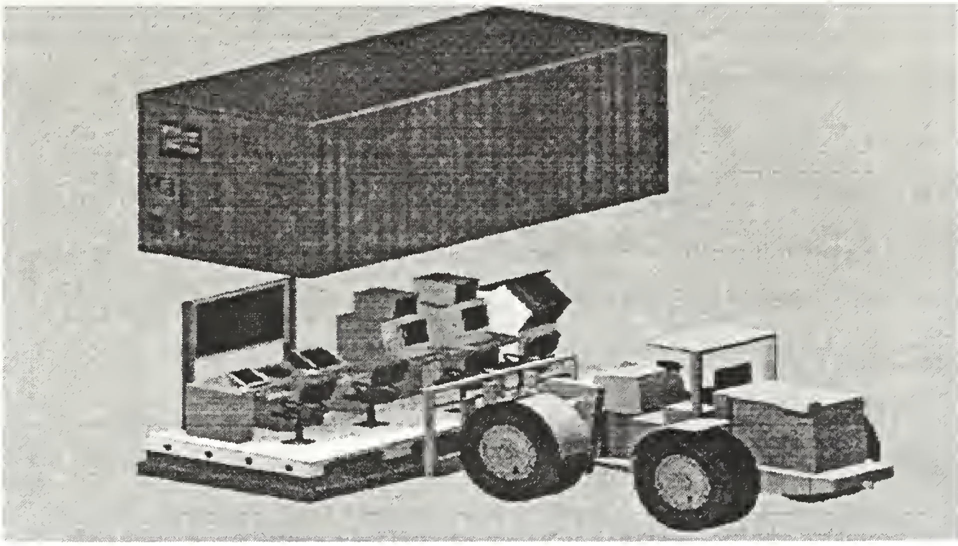


Figure 11 Cover and platform

One point to consider is whether this design or one of the other proposed MF concepts is approved for a future carrier, is the effect it has on the ship's structural strength. For a carrier, the gallery deck, hangar deck and hangar side bulkheads are key structural members and are needed to account for the longitudinal bending of the ship [Ref 44]. Any design concept on CVNX that uses MFs will require a careful review and study on its impact to the ship integrity and ballast.

2. Fixed vs. Mobile Spaces

A trade study was conducted by Naval Air Warfare Center Aircraft Division Lakehurst (NAWCADLKE) for NAVAIR Code 3.0 to consider the use of fixed versus Mobile Maintenance facilities (MMFs) for the design of AIMD spaces aboard CVN-77 [Ref 45]. To assess the practicality of pursuing a mobile AIMD facility concept for the design of CVN-77, the study addressed a variety of issues and outlined the risks and benefits

associated with mobile versus fixed AIMDs. The area that concerned space utilization will be used for this analysis.

A fixed AIMD allows the aircraft carrier to take advantage of all space and layout shops in an efficient manner. Each fixed workspace is optimized to its fullest potential. The MF could potentially restrict the space utilization aboard the aircraft carrier. Previously it was noted that when the CASS system was placed in the MALS initially, the footprint required grew by approximately 30% [Ref 28]. With a minimum of four ECUs per CASS, a doublewide trailer requirement, and an additional chiller unit required to support CASS, each aircraft carrier requires a minimum of 36 MFs for the CASS stations alone.

To further illustrate the space limitation issue, we will use as an example a current existing 40'x 20' fixed AIMD shop layout which can presently accommodate five CASS stations [Ref 45]. Using MFs, the same space on the ship can only accommodate four CASS stations due to footprint restrictions for the individual MFs [Ref 45]. Also, if the space was rounded due to its location in reference to the ships hull, the use of a standardized MF (8'x 8' x20') would prevent the ship from taking full advantage of the space as well, since the MF is rigid and inflexible. The MF also utilizes excess space since personnel are required to have ample room to properly work on equipment and move about inside the MF structure.

Current MFs have limited overhead space for cooling air ducts and do not provide sufficient room for cooling air to mix with ATE exhaust air. The fixed AIMD has more than sufficient space for ducting cooling air to avoid shop hot and cold spots. Additionally, the layout of the equipment would be restricted to the footprint of each MF. If ATE was installed such that it overlapped two or more MFs, this ATE would have to be installed after the MF was placed aboard the ship [Ref 45]. It is estimated that replacing the existing fixed avionic workspaces with 100

MFs on CVNX will require an additional 35-40 percent more space than the current avionics workspace occupy on the Nimitz-class carriers [Ref 44]. On a platform where space is at a premium, this would be very difficult to implement without redesigning other ship work areas to accommodate this "growth" in size caused by the MF requirements.

3. Crossdeck

Under the proposed system, the shipboard avionics area made up of approximately 100 MFs and 80 people would go ashore to the NAS AIMD during the aircraft carrier's availability periods. This will allow the sharing of assets at the ashore site. Potentially, one ship could come back from deployment, the vessel would then give up its MFs to the next deployer. The MF concept will also assist in reducing duplication of tool, spare parts, and equipment inventories, alleviating the need to have duplicate items for both ship and shoreside facilities. This is a prime target, since assets in the air community can typically sit unused on a ship for 8-months to over a year at a time.

DoD has recognized that electronics testing is a high cost driver. There was over $51 billion spent on ATS during the 1980's. DoD is serious about reducing the total ownership cost of ATS, achieving flexibility through interoperable ATS functions, and supporting multiple platforms across multiple levels of maintenance (O, I, D)[Ref 46]. The comptrollers could determine a way to do more with less and cut back support funds to the aviation program. There is a potential that the Aircraft Procurement Navy (APN) and Operations and Maintenance, Navy (OM & N) budgets would be targets of opportunity, and budget cuts could occur if potential savings are seen with the "sharing of assets."

With the current fiscal environment, where the lack of funds prevails, it often means there is not enough "equipment" to go around to support all units. The MF concept of operations would lend itself to

regular transfer of assets from one activity to another. What is likely to occur is that the MF or part of it would not make it to the proposed ashore site, but would probably be crossdecked to another aircraft carrier. Some of the MFs may be perceived as targets for cannibalization as well. Fleet readiness will suffer and the possibility of less CASS system procured for the Navy is imminent.

I. SURVEY ANALYSIS

In order to better understand the aviation maintenance environment and obtain a hands-on feel for the impact that MFs may have on an aircraft carrier, surveys were sent out to Navy AMDO professionals. In total 60 surveys were sent via e-mail by the author, and 20 were received back, a 33% response rate. Not all of the questions were answered by all of the respondents. As the research and analysis portion of this study progressed, some initial questions on the questionnaire were no longer significant to the research undertaken, and were not utilized for this paper. The questions that were not used by the author were numbers 2, 3, 8 and 10. The questionnaire is included at Appendix I.

Generally, opinions to the proposed system were overwhelmingly unfavorable. All respondents decided to answer # 1, and 85 percent thought that if MFs were used for I-level support, the avionics area was the ideal target to apply the concept to. A variety of responses were received for question # 3, cost was the biggest one (on 75 percent received). Other areas that demand modularization that were mentioned are: technology, test benches, TPS, future roles and missions of the aircraft carrier, and CVW/squadron specific.

Question # 4 dealt with the future impact of CASS, the driving factor on that is space. Over 50 percent of those that responded believed that CASS would be “micronized” to reduce the existing footprint in the

near future, and that cooling and power stability were significant factors to consider when inserting CASS into a MF.

Question # 5 provided the most varied of all responses. Many believed no impact would occur to the current structure (30 percent). The largest impact seen was to the SEAOPDET ashore; over 60 percent indicated that major changes would occur in this area. Only 10 percent saw any impact on training and advancement, and of those it was minimal. Mixed results were received on the last part of question # 5. Some respondents believed the officers should remain onboard, others believed that the MF should go ashore but the personnel should remain; the NAS AIMD ashore would be responsible in this case for the MF (10 percent of respondents for the latter). Most of the results received to the questionnaire regarding this particular question have been incorporated in the analysis section of Chapter IV.

Question # 6 asked the strengths and weaknesses of the implementing this proposal. Over 60 percent indicated that flexibility and manpower efficiencies were a strength. Another asset indicated was utilization rate of the equipment since it would be used both at sea and at the proposed site ashore vice remaining idle on the ship during the availability, 30 percent. Some indicated that fewer assets required were also a strength, 30 percent. However, 50 percent indicated that fewer assets (sharing) was also a weakness of the proposal. The majority of the responses to this question were in the weakness category. The responses and percentage that indicated this response, are listed below in bullet format for convenience:

- Equipment may be damaged in transit, multiple moves [70 percent]
- Maintenance cost MF will require [60 percent]
- Configuration management and costs to adapt MF [50 percent]
- Need more people to support the MF, i.e. Maintainers (AS) [40 percent]
- Footprint required on CVN for MF is too large [40 percent]

- Opportunity to share assets, will led to smaller amount of SE and CASS systems purchased (less than # of carriers) and crossdeck will occur [40 percent].
- Transportation cost of concept [30 percent]
- Life cycle costs of MF, ancillary gear, etc [25 percent]
- Crossdeck of assets [25 percent]
- Space and location ashore to complex MF is insufficient [15 percent]
- Ownership, accountability and inventory [10 percent]

Seventy percent of those that answered # 7 indicated that between deployments, while the ship is undergoing an availability period, is the ideal time to implement the proposed system. The remaining respondents did either not answer the question or responded negatively to the concept and stated they would never offload MFs.

Costs that may be generated from this proposal were mainly towards the maintenance cost of the MF, as previously mentioned above. Over 50 percent of respondents were concerned with what they perceived high maintenance costs associated with the MF. Other cost areas mentioned were Ship Construction Navy (SCN), dealing with configuration changes on the aircraft carrier, installation and removal cost associated with the MF while on the ship, and Military Construction (MILCON) for the ashore sit [40 percent on the three mentioned]. The last cost area of concern, 35 percent of the questionnaires returned, were the configuration costs associated with designing/engineering, outfitting, and upgrade of the MF.

For question # 10, most respondents indicated they previously answered this question in the answers to the other questions asked. Only 50 percent actually filled out a response to this question. Of that 50 percent, maintenance costs was the clear cut concern again (60 percent, or 6 of 10). The other concern is what would occur when the MF is not available, or not at 100 percent readiness, who is responsible for getting the MF and SE and ready for use (40 percent).

Question # 11 asked for additional comments. Most of these were previously broken out with the responses above and will not be discussed

again since they were lumped in with the earlier questions by the author. On 40 percent of the questionnaires, there was general concern on who would remove and then reinsert the MF into the workspace onboard the carrier. There was also some concern on the ship/shore interfaces of the MF and if the MF was integrated with carrier design (both 20 percent). Another area addressed was the cooling required by CASS and the impact the requirement would have on the MF (15 percent).

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V. CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

The final chapter of this thesis provides a summary; conclusions and recommendations based on the analysis of the proposed system. Additionally, further research questions are proposed pertaining to the AIMD structure on the next generation aircraft carrier

Today's budget constraints are forcing DoD components to reexamine the way they do business. Operating and Support (O&S) represent a significant portion of naval aviation's Total Obligation Authority (TOA) and recently have been under attack as other efforts are deemed more important (i.e. recapitalization). Numerous studies have been prepared and alternative maintenance concepts reviewed in attempting to reduce O&S costs, while still maintaining the level of service at or higher than before.

The Navy remains committed to a 21st century aircraft carrier (CVNX) utilizing advanced technological applications. The goal is to create a sea based tactical air platform that not only retains the warfighting relevance of the NIMITZ class, but also is designed with architecture for change. This approach will allow the Navy to take advantage of maturing technologies that not only enhance warfighting capabilities but also provide opportunities to reduce lifecycle costs.

Fixed shipboard AIMD facilities represent the status quo for aircraft carrier design, mobile AIMD facilities (MFs) would be a paradigm shift and additional investment costs would be expected to incorporate this feature on CVNX. Also, significant costs would be expected to backfit MFs into existing aircraft carriers to standardize the carriers and reach efficiencies.

B. CONCLUSIONS

The movement of the avionics area of an aircraft carrier AIMD ashore during availability periods is a complicated undertaking, involving a myriad of assets and impacting numerous logistical aspects. The changes that would need to occur in the current and proposed system of intermediate maintenance have substantial economic and operational impacts.

Implementation and operations in the proposed system from an ashore perspective would entail significant costs. These costs include procuring the MF shell, configuring the MF based on customer requirements, repositioning the MF to the ashore site and then back to the carrier, SE and ancillary gear required to support the concept ashore, and maintenance costs associated with the MF. A summary of the estimated costs involved with the implementation and operation of the proposed system are shown in Table V-1.

AREA OF CONCERN	PRICE($K)
Construction of three van pads for complexing	2,700
Initial procurement of 100 MF, shell	3,550
Cost of INUs required (15/system)	53
Estimated cost to configure MF	4,000
Transportation costs (worse case scenario)	320
MF ancillary gear and ashore SE required	2,000
Annual estimate for maintenance on 100 MFs	300
TOTAL COSTS	12,923

Table V-1 Summary of costs for implementation of proposed system

The prices listed above do not include the costs associated with the removal and installation of the MF once onboard the aircraft carrier. The purpose of this study was to look at the ashore requirements. Starting and ending with the MF on the elevator either for removal or installation

from/to the carrier. The costs in Table V-1 are for each proposed site, which is for one aircraft carrier.

The actual cost, from an ashore perspective, if the concept was applied to all CVNX ships and then retrofitted to Nimitz-class ships is approximately $155 million. That cost would apply to the proposed system if it were implemented immediately, using current prices for all 12 carriers. The most significant cost is the procurement, configuration and life-cycle maintenance of the MF. The maintenance cost is for one year in the proposed system. If the estimated 20-year lifecycle maintenance costs of the MF were factored in, the cost would be significantly higher.

Implementing the proposed system at the ashore NAS AIMD could be operationally feasible if enough money was invested in the Naval Aviation maintenance program to materially support it. Large initial investments would need to be made in the procurement and configuration cost of MFs. For the MF concept to be successful it must have standardization among the carriers or you do not achieve the desired efficiencies. A team of Maintenance Officers (USN and USMC), logisticians, engineers, aircraft carrier shipyard experts, TYCOM, NAVAIR, OPNAV and actual customers (ship and ashore AIMD Officer) should be assembled to investigate the feasibility of the proposed system.

Other areas besides costs will impact the proposed system. The uncertainty of the T/M/S of aircraft and the level or support required when CVNX hits the fleet, changing and uncertain missions for the Navy, microsizing of the CASS system and potential modularization of benches, manning structure changes, and other alternatives to the proposed system all impact the proposed concept. We believe that crossdecking, sharing of assets and cannibalization of the MFs would occur before the previous shipboard carrier assets ever made it to the proposed site. Adding an MF just adds an extra level of equipment to be maintained. CVNX spaces

should be designed to provide for modular installation of test benches such as CASS and its future revisions.

C. RECOMMENDATIONS FOR FURTHER RESEARCH

The following issues are suggested for further investigation:

- What is the cost associated with configuring MFs?
- Are MFs ashore and afloat configured the same?
- Will generators be required in the proposed system ashore?
- Who supports the squadron between the end of each deployment and offload/delivery of the MF from the carrier to the proposed site?
- What impact does CASS replacements have on this proposal?
- Who pays if equipment inside the MF is damaged in transit?
- How would the MF concept affect O-level maintenance and operation? Could the MF concept be further applied to squadrons?
- What are the environmental impacts of placing MFs ashore?
- What impact would MFs have on the quantity of test benches, maintainers, CASS systems, readiness (sharing of assets)?
- What is the impact on AMDO manning of the proposed system?
- What are the SHIPALT costs involved if implemented?
- What are the ship ballast and engineering impacts of placing MF onboard?
- What is the impact on PERS-TEMPO to the SEAOPDET?
- Who ensures that the MF is 100 percent ready when delivered, and that "grooming" is not required? Whose AVDLR finds are used to bring the MF to 100 percent full mission capable?
- What impact does the current O-to-D and O-to-commercial maintenance philosophy have on the proposed system?
- What benefits would a mix of mobile AIMD and fixed spaces provide to the user and other sites?

APPENDIX A. DEFINITIONS

ABBREVIATION	DEFINITION
AFM	Aviation Fleet Maintenance
AIMD	Aircraft Intermediate Maintenance Department
ANSI	American National Standards Institute
APL	Allowance Parts List
APN	Aircraft Procurement, Navy
ATE	Automated Test Equipment
CAD	Computer Aided Design
CASS	Consolidated Automated Support System
CCSP	Common Contingency Support Package
CIP	CASS Installation Plan
CMC	Commandant of the Marine Corps
CNAL	Commander, Naval Air Forces, Atlantic
CNAP	Commander, Naval Air Forces, Pacific
CNO	Chief of Naval Operations
COMMARFOR	Commander Marine Forces
COMNAVAIRLANT	Commander, Naval Air Forces, Atlantic
COMNAVAIRPAC	Commander, Naval Air Forces, Pacific
COMNAVAIRSYSCOM	Commander, Naval Air Systems Command
CONUS	Continental United States
CSE	Common Support Equipment
CSP	Contingency Support Package
CVB	Carrier Battle Group
DLA	Defense Logistics Agency
DoD	Department of Defense

ECU	Environmental Control Unit
EMMMF	Expanded Mission Mobile Maintenance Facility
ICP	Inventory Control Point
ILS	Integrated Logistic Support
ILSP	Integrated Logistic Support Plan
IMRL	Individual Material Readiness List
INU	Integration Unit
INUMF	Integration Unit Mobile Facility
ISO	International Organization for Standardization
JOCOTAS	Joint Committee on Tactical Shelters
MALS	Marine Aviation Logistics Squadron
MALSP	Marine Aviation Logistics Support Program
MF	Mobile Facility
MFP	Mobile Facility Program
MFSO	Mobile Facility Side Opening
MHE	Material Handling Equipment
MMF	Mobile Maintenance Facility
MRC	Maintenance Requirement Card
MRI	Material Requisition Issue
NADEP	Naval Aviation Depot
NADEPNI	Naval Aviation Depot, North Island
NAMP	Naval Aviation Maintenance Program
NAVAIR	Naval Air Systems Command
NAVAIRHQ	Naval Air Headquarters
NAVAIRSYSCOM	Naval Air Systems Command
NAVFAC	Naval Facilities Engineering Command
NAVICP	Naval Inventory Control Point

NAVSEASYSCOM	Naval Sea Systems Command
NAWCADLKE	Naval Aviation Warfare Center Aircraft Division, Lakehurst NJ
NI	North Island
NSN	National Stock Number
O&M, N	Operations and Maintenance, Navy
OPNAVINST	OPNAV Instruction
PAX RIVER	Patuxent River
PSE	Peculiar Support Equipment
RO/RO	Roll-on/Roll-off
SE	Support Equipment
SM&R Code	Source, Maintenance, and Recoverability Code
SOMF	Side Opening Mobile Facility
TBA	Table of Basic Allowances
TEU	Twenty Foot Equivalent Unitl
TYCOM	Type Commander

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APPENDIX B. DEFINITION OF TERMS

1. Integration Unit (INU) - A MF with side panel openings designed to join the INU with end door opening of other MFs. The result is an integrated complex. The INU ties MFs together, distributes electrical power, provides administrative and supervisory workspace, and may contain tie-down fixtures to secure loose equipment for transportation when the complex is relocated.

2. Internal Configuration - The process or result of installing Environmental Control Units (ECUs), benches, wiring, power panels, and similar items in the MF.

3. ISO/ANSI Container - An article of transportation equipment meeting applicable ISO and ANSI standards and designed to be transported by various modes of transportation without configuration change when moving from one mode of transportation to another. Included in this definition are modules or clusters configured so they can be coupled to form an integral unit meeting ISO or ANSI standards for movement. Containers may be utilized for transporting cargo or housing equipment, personnel, or portable maintenance and storage facilities.

4. Ancillary Equipment - Generators, mobilizers, spreader bars, mobile frequency converters, lifting slings, jacks, ECUs, solid state frequency converters, grounding rods, butting kits, power cables, etc. Appendix B provides the format and the equipment to be accounted for during inventories. Other equipment will be accounted for in the MF Logbook and Inventory Records (LIR).

5. Mobile Facility (MF) - A habitable, relocatable, rigid-walled, expandable or non-expandable tactical shelter or special purpose shelter designed to provide environmental control and to contain equipment in support of aviation weapon system maintenance, tactical operations, logistics, and administrative functions. An item of non-self-propelled

equipment without permanently attached wheels or chassis designed to be transported on specially designed mobilizers. Also referred to as a tactical shelter or relocatable structure.

6. Mobile Facility Complex - Two or more MFs either joined together or located in immediate proximity of each other, with necessary related equipment.

7. MF Program Equipment - Consists of MFs and ancillary equipment. MFP Equipment is used for maintenance or operational support of Navy and Marine Corps aviation systems.

8. Outfitting - The process of installing the prime equipment in the MF to make the unit totally functional.

9. Prime Equipment - That equipment which the MF is designed specifically to contain. This includes maintenance SE and material storage equipment as well as administrative and operational support items.

10. MF Side Opening (MFSO) - A MF with one or two completely removable sidewall panels. Mobile Facility Type A Side Opening (MFASO) is constructed with one removable sidewall. It features a personnel access door on each end and has openings for two ECUs on the rigid non-removable sidewall. Mobile Facility Type B Side Opening (MFBSO) is constructed with one removable sidewall. It features a hinged door between two ECU openings on the rigid non-removable sidewall. MFBSO(Mod) is a MFBSO with an 80" door in one end to permit induction of oversized equipment for repair. Mobile Facility Type C Side Openings (MFCSOs) are constructed with both sidewalls removable. It has a personnel access door on one end only. With sidewalls removed, MFASO and MFBSO may be complexed side by side to provide twice the normal workspace or an MFASO, MFBSO and one or more MFCSOs may be complexed to form an expanded workspace.

11. Support Equipment (SE) - Inclusive of Common Support Equipment (CSE) and Peculiar Support Equipment (PSE). When installed in MFs, SE

is considered to be prime equipment and is installed during the outfitting process. A designated Navy industrial configuration activity or contractor may install SE if a permanent installation is required. The user will install all portable SE.

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APPENDIX C. TYPES OF MAINTENANCE

The organizational level performs preventive maintenance, limited repairs, check and test, and removed and replacement of weapons replaceable assemblies (WRAs). Organizational maintenance is performed at the user level that has custody of aeronautical equipment, usually the squadron. The goal of O-level maintenance is to allow a squadron to support its own operations [Ref 2].

Intermediate level maintenance is a more intricate level of maintenance that is performed on aviation related systems and components and provides both directed and indirect support for the O-level maintenance effort. Intermediate maintenance level repair is performed either ashore at the Naval Air Station (NAS) Intermediate Maintenance Activity (IMA) known as Aviation Intermediate Maintenance Department (AIMD), or AIMD on aviation capable ships with more than one embarked squadron, or at Marine Aviation Logistic Squadrons (MALS). Intermediate maintenance concentrates on engine and component repair rather than on aircraft maintenance. The goal of I-level maintenance is to enhance and sustain the mission capability and readiness of supported units [Ref 2].

Depot level maintenance is the highest level of maintenance. It involves complete aircraft, engine, and component overhaul and is performed mainly at Naval Aviation Depots (NADEPs), contractors, and other industrial establishments designated by the type commander. The goal of D-level maintenance is to support O- and I-level maintenance activities. It is accomplished by performing maintenance beyond capability of maintenance (BCM) of the lower levels, usually on equipment requiring major overhaul or rebuilding of end items, assemblies, and parts [Ref 2].

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APPENDIX D. MOBILE FACILITY CHARACTERISTICS

ISO/ANSI ISO 668/1161/1496 and ANSI MF 5.1.1M **ASTM** Designation: PS 27 - 95 **Exterior Dimensions** 96in. high, 96in. wide 238 ½ in. long **Interior Dimensions** 84 ½ in. high, 90 in. wide, 232 ¼ in. long **Exterior Finish** Glossy white polyurethane **Tare Weight** 5235 lbs. **Doors** 48 in. by 76 in.; located at each end of the mobile facility **Floor Loads** 138 lbs/ft2 uniform Loads	**Maximum Payload** 14765 lbs. **Heat Transfer** Insulated to provide a heat transfer coefficient of 0.25 BTU/hr/ft2/deg F **Temperature Range** -40 deg F to + 125 deg-F plus solar load to minimum of +180 deg F **Roof** 660 lbs on an area 24 in. by 12 in. **Service Life** 20 years **Transportability** All Modes

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APPENDIX E. TYPES OF MOBILE FACILITIES

There are several functional categories of MFs presently in use. These include maintenance shops, supply shops, supply support spaces, and administrative units. Maintenance shops provide facilities for avionics repair, micro-miniature component repair, machine shop work, and automated test equipment. Supply support MFs are used in conjunction with the maintenance shops. Administrative office, production control, and quality assurance functions are accomplished in administrative MFs. Development of the new mobile facility side opening (Type A and Type B in 1979, Type C in 1986) added a new dimension to mobile facility utilization. Positioning two or more mobile side opening facilities adjacent to each other to create unlimited continuous floor space can now accommodate applications previously considered impractical because of limited floor space of a single unit. Applications for side opening mobile facilities include automatic test equipment installations, classrooms, conference rooms, and airframe maintenance.

1. Integration Unit (INU)

The integration unit (INU) provides a method of joining basic, side opening and integration unit mobile facilities into a functional, environmentally controlled complex (See Figure 12). The INU also serves as a corridor, an electrical power

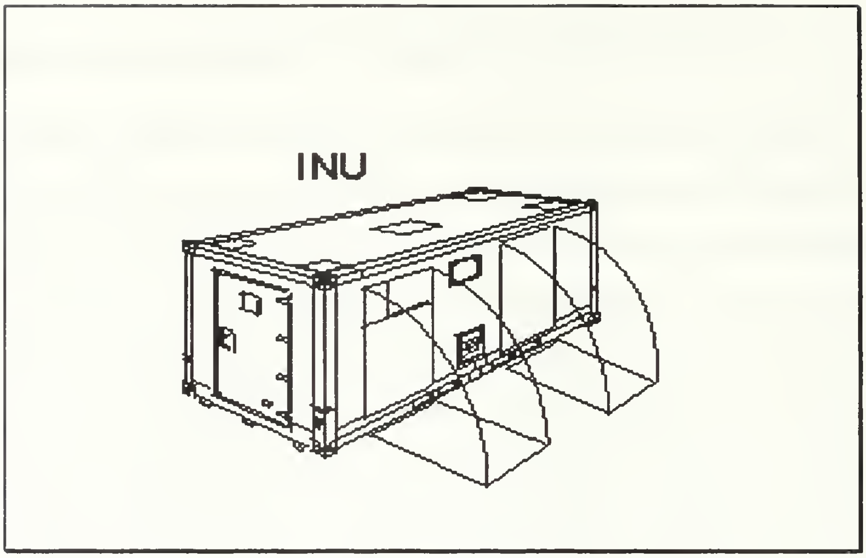

Figure 12. Integration unit [Ref 4]

distribution control unit, and a production control supervisory/administrative workspace. The INU also features three removable side panels of the same size, two on one side and one on the other. These panels and doors permit mobile facilities to be attached to either the end or the side of the INU.

2. Mobile Facility Side Opening (MFSO) Type A

The MFSO Type A (See Figure 13) has one personnel door at each end. The left side contains two removable panels where environmental control units may be installed. The right side contains a removable side panel assembly. When removed, the side panel assembly stores securely on the roof. Removal of the side panel assembly allows the MFSO Type A to join another MFSO side by side.

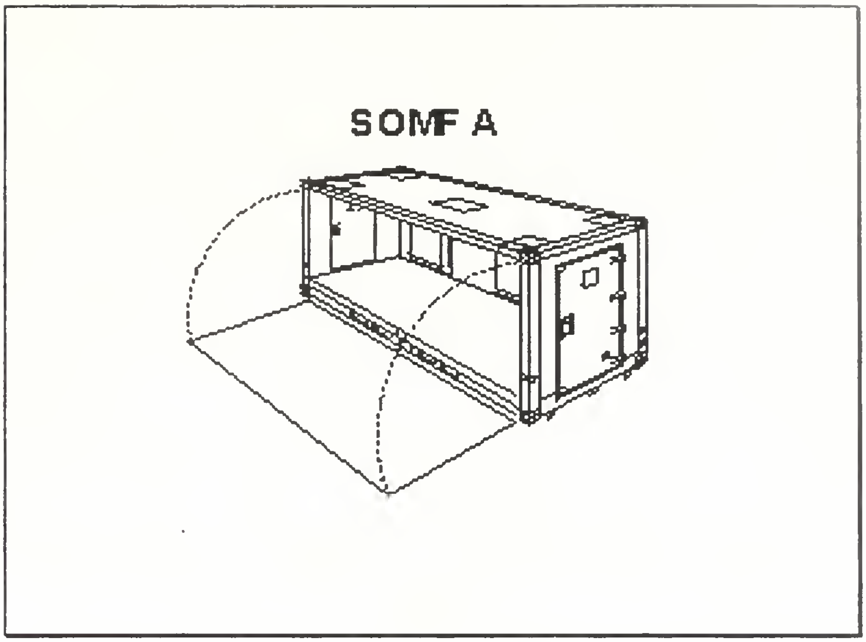

Figure 13 Mobile Facility Side Opening Type A [Ref 4]

3. Mobile Facility Side Opening (MFSO) Type B

The MFSO Type B (See Figure 14) has no end personnel doors. The left side contains two removable panels where environmental control units may be installed. A small, non-standard door is installed between environmental control unit removable panels. The right side contains a removable side panel assembly. When removed, the side panel assembly stores securely on the roof. Removal of the side panel assembly allows the MFSO Type B to join another MFSO side by side.

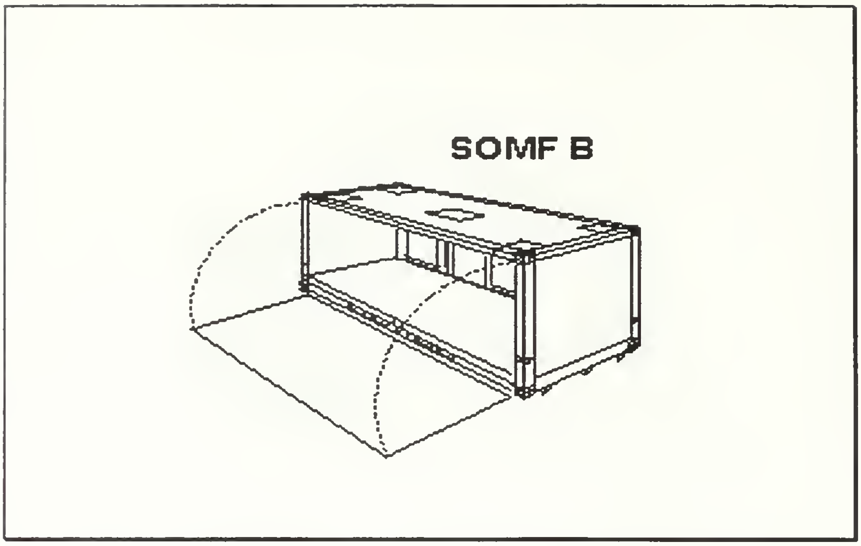

Figure 14 Mobile Facility Side Opening Type B [Ref 4]

4. Mobile Facility Side Opening (MFSO)Type B (Modified)

The MFSO Type B (Modified) is identical to the MFSO Type B, except that large double doors are installed at the rear of the mobile facility (See figure 15). The double doors allow large equipment to be brought into the mobile facility for repair or other work.

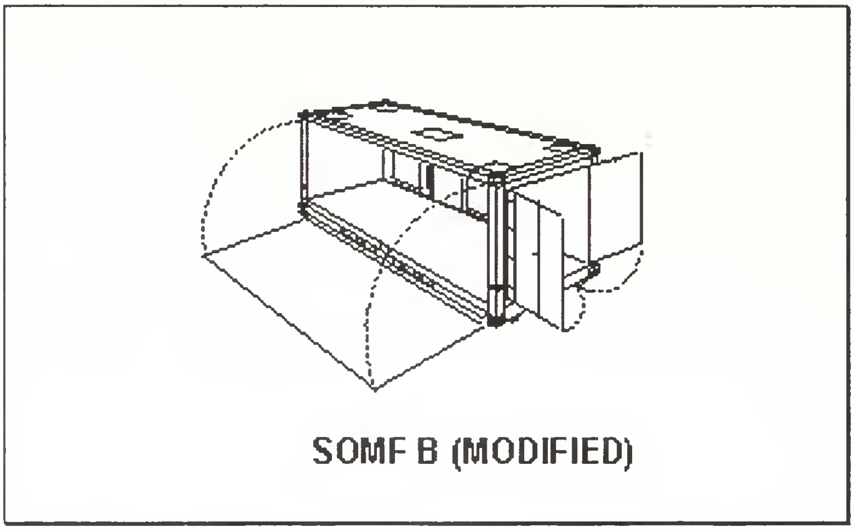

Figure 15 Mobile Facility Side Opening Type B Modified [Ref 4]

5. Mobile Facility Side Opening (MFSO) Type C

The MFSO Type C (See Figure 16) has one personnel door at the front end. Each side contains a removable side panel assembly, both side panel assemblies store securely on the roof. Removal of the side panel assemblies allows the MFSO Type C to join another MFSO side by side.

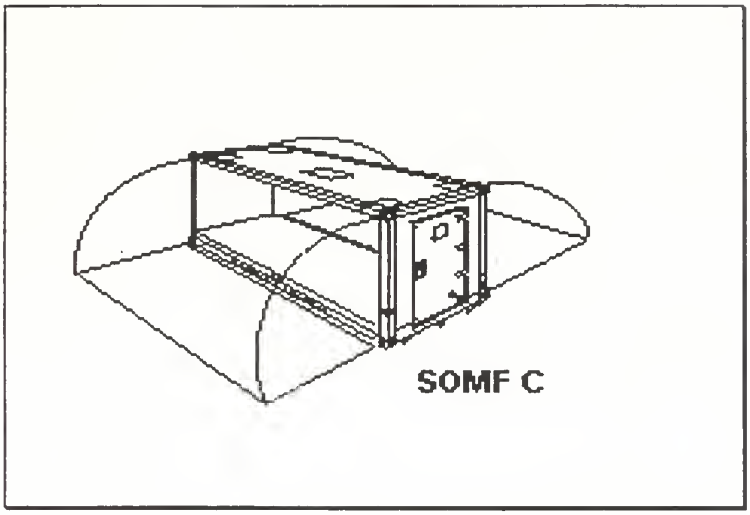

Figure 16 Mobile Facility Side Opening Type C [Ref 4]

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APPENDIX F. RESPONSIBILITIES

ADDITIONAL RESPONSIBILITIES FOR MF PM (CODE 3.1B.4)

(1) Act as command focal point and coordinate overall action within NAVAIR relative to MF Program equipment.

(2) Receive and consolidate all NAVAIR MF requirements.

(3) Develop and maintain consolidated requirements planning data for budgeting, funding, and procurement of MF Program equipment.

(4) Develop requirements and plan for replenishment of MF Program equipment based upon retirement factors.

(5) Review and compile requirements provided by AIR-3.1, Air Program Coordinators (APCs), Program Executive Office, Air (PEOs), or others for MFs and process requirements.

(6) Act as the Primary Inventory Control Activity (PICA) for DOD and is responsible for providing material under this program through normal service channels. Responsibilities include the functions of replacement computation, budgeting and funding, procurement, receipt, storage and issue, depot level maintenance, cataloging and disposal.

(7) Compile and maintain total cost estimates for MF equipment, including internal MF configuration and outfitting costs.

(8) Develop and provide descriptive justification for O&M,N and APN funding requirements for the MF Program.

(9) Maintain records of commitments, obligations, and expenditures for the O&M,N line item "Mobile Facilities".

(10) Budget, fund, and manage the acquisition of MF equipment.

(11) Provide inputs to Naval Inventory Control Point (NAVICP) to assist in development of the transportation budget.

(12) Perform research, design, development, testing and acquisition management of all MF equipment. This responsibility includes, but is not limited to, the requirement to:

(a) Ensure compatibility with current and planned commercial and DOD air and surface transportation systems;
(b) Ensure that the MF design provides for multi-application and that the procurement specification contains appropriate criteria contained in American National Standards Institute (ANSI) MH5.1.1M, "requirements for Closed Mobile Facility Cargo Containers", and are approved as certified safe containers;
(c) Coordinate with Aircraft Launch and Recovery Program Office (PMA251) to ensure that the MF design is compatible with ship installation requirements;
(d) Maintain design, technical, and configuration control over specifications and other engineering data for MF Program equipment procurements;
(e) Prepare and update, as required, applicable specifications for procurement of MF Program equipment.
(13) Exercise logistics management for all authorized procurements of MF program equipment, and function as chairperson of the MF Program Review meetings. Publish logistic support policies via User Logistic Support Summary (ULSS) per NAVAIR Instruction 4000.14A.
(14) Approve actions concerning logistic support requirements for MF Program equipment. The AIR-3.1 Logistics Manager (LM) exercises the same Integrated Logistic Support (ILS) responsibilities for MFs as AIR-3.1 for weapon/airborne systems.
(15) Advise NAVICP Mechanicsburg of quantities and types of MF equipment required by Marine Corps aviation units for inclusion in applicable allowance lists.
(16) Compile and forward MF internal configuration and outfitting requirements to either Public Works Center, (PWC) Norfolk, Virginia (NORVA) or Naval Aviation Depot, (NAVAVNDEPOT) North Island (NORIS).

(17) Initiate O&M,N funding documents to appropriate commands and Navy activities for labor and materials in support of the MF Program.

(18) Represent NAVAIR on Navy and DOD tactical shelter and containerization committees and related programs.

(19) Provide reports of containerization projects within NAVAIRHQ as directed by OPNAV.

(20) Provide outyear MF workload planning, priorities, and execution guidance to industrial activities.

(21) Ensure the existence of an industrial workload capability commensurate with workload requirements.

(22) Coordinate with ACCs, Commandant of the Marine Corps (CMC), or requiring activities for the installation, checkout, and verification of MF assigned prime equipment.

PROCUREMENT MANAGEMENT AND INDUSTRIAL BASE SUPPORT DIVISION (AIR-1.3.2)

(1) Responsible for producing and maintaining the Weapon System Planning Documents (WSPD).

(2) To the maximum extent practicable, the letter/number designators and nomenclature of avionics and other systems supported from the MF should be included in the data provided to Procurement, Management and Industrial Base Support Division. MF planning information will be included in the WSPD for specific weapons systems.

COMPTROLLER AND FINANCIAL MANAGEMENT DEPARTMENT (AIR-7.6.1.3) WILL PROVIDE THE FOLLOWING OPERATIONS AND MAINTENANCE, NAVY (O&M,N) SERVICES

(1) Coordinate funding requirements for inclusion in appropriate planning and budgeting submissions.

(2) Furnish guidance for justification of budget requirements

(3) Provide financial guidance and assistance in the execution of the program.

AVIATION TRAINING SYSTEMS PROGRAM OFFICE (PMA205)

(1) Provide planning to identify manpower and training requirements associated with the maintenance and operation of MF equipment;

(2) Direct and coordinate the development of personnel requirements to support MFs assigned to squadrons and AIMDs;

(3) Coordinate the review of personnel planning data within NAVAIR Head Quarters (HQ) and forward this data with comments and recommendations; and

(4) Coordinate with Facilities Management/Environmental Program Department (AIR-8.0Y) and with training sites to determine mobile training facility requirements.

AVIATION SUPPORT EQUIPMENT PROGRAM OFFICE (PMA260)

(1) When procuring new support equipment destined for MF installation, coordinate with MF PM and the Assistant Program Manager for Logistics (APMLs) to ensure the equipment is compatible with the MF parameters in respect to size, weight, power requirements, and environmental matters.

(2) Provide MF PM with equipment delivery schedules and destinations for all MF installed equipment and provide changes as they occur.

AIRCRAFT LAUNCH AND RECOVERY PROGRAM OFFICE (PMA251)

(1) Provide to MF PM peculiar ship installation design, configuration and utility service requirements that pertain to MFs.

(2) Coordinate aviation requirements for the Fleet Modernization Program (FMP) with Naval Sea Systems Command (NAVSEASYSCOM) and ensure

applicable data is loaded in the Fleet Modernization Program Maintenance Information System (FMPMIS).

(3) Coordinate all matters related to MF ship installations with NAVSEASYSCOM.

NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION LAKEHURST

(a) Determine space and weight constraints imposed upon the design of SE to be used in a MF. NAVAIRWARCENACDIVLKE will have prime responsibility for annotating the Support Equipment Recommendation Data (SERD) sheets with appropriate codes as specified in Data Item Description DI-ILSS-80039A and NAVAIR Instruction 13650.1C for MF installed SE, for example, system 669V.

(b) Provide MF equipment research, design, development, and engineering assistance as directed by NAVAIR MF PM.

(c) Provide logistic support services as directed by MF PM.

(d) Maintain and update MF procurement data package.

(e) Initiate procurement of MFs and related equipment as directed by MF PM.

NAVAVNDEPOT NORIS

(1) Perform Limited Logistics Management (LLM), Basic Design Engineering (BDE), In-Service Engineering (ISE), and Production Support for the outfitting and design of NAVAIR internal MF configurations. NAVAVNDEPOT NORIS's major areas of responsibility are as follows:

(a) Act as FST for all internal MF configurations. This includes all government furnished equipment (GFE) and outfitting material installed by either Navy organic configuration sites, original equipment manufacturer sites, and/or users of MFs.

(b) Ensure standardization of materials used for installing equipment in NAVAIR MFs.

(c) Coordinate the repair or modernization of NAVAIR MF program equipment as required.

(d) Maintain configuration control of all NAVAIR MF configuration designs. This includes all NAVAIR MF configuration drawings produced by Navy organic activities and private contractors. Maintain a historical database capable of cross-referencing MF serial numbers and outfitting site project number (where applicable) to specific MF drawings used to configure and outfit the MF

(e) Provide engineering support to DOD organic MF outfitting sites and private contractor sites (through the Contracting Officer's Representative). Review and evaluate requested deviations from established internal configuration designs. Determine impact to safety, intended form, fit, and function of the MF, MF production delivery schedule, and MF user readiness prior to rendering a decision on the requested deviations. Document all requests for deviation and decisions rendered.

(f) Ensure that ship installation design requirements are such that minimum physical changes to MFs are required and the MF retains its compatibility with other MFs when moved ashore.

(g) Develop new MF internal configuration designs as directed by the MF PM. Coordinate basic layout of new MF internal configuration and coordinate design review with designated Fleet user and production site representatives prior to MF PM design acceptance.

(h) Maintain the master repository of all NAVAIR MF configuration drawings. Update these drawings as required.

(i) Perform financial management functions relative to production of MF configurations, LM, (BDE) and ISE responsibilities. This includes developing and maintaining a financial requirements profile and

monitoring, documenting, and auditing as required to account for all funds provided for production, engineering, and logistics support.
(j) Perform workload management at NORIS for the production of configured MFs, including site capability assessments; workload planning; and workload scheduling, monitoring, and adjustment.
(k) Perform inventory management for NAVAIR owned MF Program equipment at NORIS. This equipment includes all major, ancillary, and configuration equipment and configuration outfitting material.
(l) Ensure MF receiving activities are advised of the MF serial number(s), internal configuration(s), ECU serial number(s), and shipping data of all NORIS shipments of MFs and related equipment. Ensure the initiation and shipment of the MF logbook(s) and LIRs with newly configured or reconfigured/repaired MFs.

NAVY PWC NORVA'S MAJOR AREAS OF RESPONSIBILITY
(1) Perform financial management functions relative to the production of MF configurations and LM responsibilities. This includes developing and maintaining a financial requirements profile and monitoring, documenting, and auditing as required to account for all funds provided for production and logistics support.
(2) Perform workload configuration management at NORVA for the production of configured MFs, including site capability assessments; workload planning; and workload scheduling, monitoring, and adjustment.
(3) Perform inventory management for NAVAIR owned MF Program equipment at NORVA. This equipment includes all major, ancillary, and configuration equipment and configuration outfitting material.
(4) Ensure MF receiving activities are advised of the new MF serial number(s), internal configuration(s), ECU serial number(s), and shipping data of all NORVA shipments of MFs and related equipment. Ensure the

initiation and shipment of the MF logbook(s) and LIRs with newly configured or reconfigured/repaired MFs.

(5) Ensure no MF is shipped to the user with less than sixty days remaining before CSC rectification is required.

(6) Provide configuration management and design engineering in support of the NAVAIR MF program when required.

(7) Participate in configuration design development with customers where actual designs are not established. Coordinate the review of these designs for customer approval.

THIS SECTION AMPLIFIES FUNDING RESPONSIBILITY AND COGNIZANCE.

(1) The MF PM has total budgeting, funding, and acquisition responsibility for all MFs and related equipment acquired in support of the NAVAIR mission. MF PM also has configuration and outfitting responsibility for all MFs acquired in support of specific NAVAIR weapon system projects and funded through the appropriate program management or program coordinator office. The MF PM retains this budget/funding responsibility whether MF configuration/installation is conducted at the weapon system contractor facility or an organic Navy activity.

(2) The use of Aviation Fleet Maintenance funds for organizational and intermediate level maintenance of MF equipment is authorized and used in support of aircraft maintenance. Expense Navy Stock Account (NSA) funded repair parts for organizational and intermediate level maintenance of MFP equipment and replacement of initial issue inventory items will be funded and administered per TYCOM instructions.

(3) Operating costs, such as those needed for engine oil, filters, and fuel for MF equipment must be budgeted and funded per TYCOM and local instructions.

(4) All MFs must have a CSC certification plate attached to the MF indicating the date when rectification will be required. No MF will be shipped with less than 60 days remaining before rectification is required.

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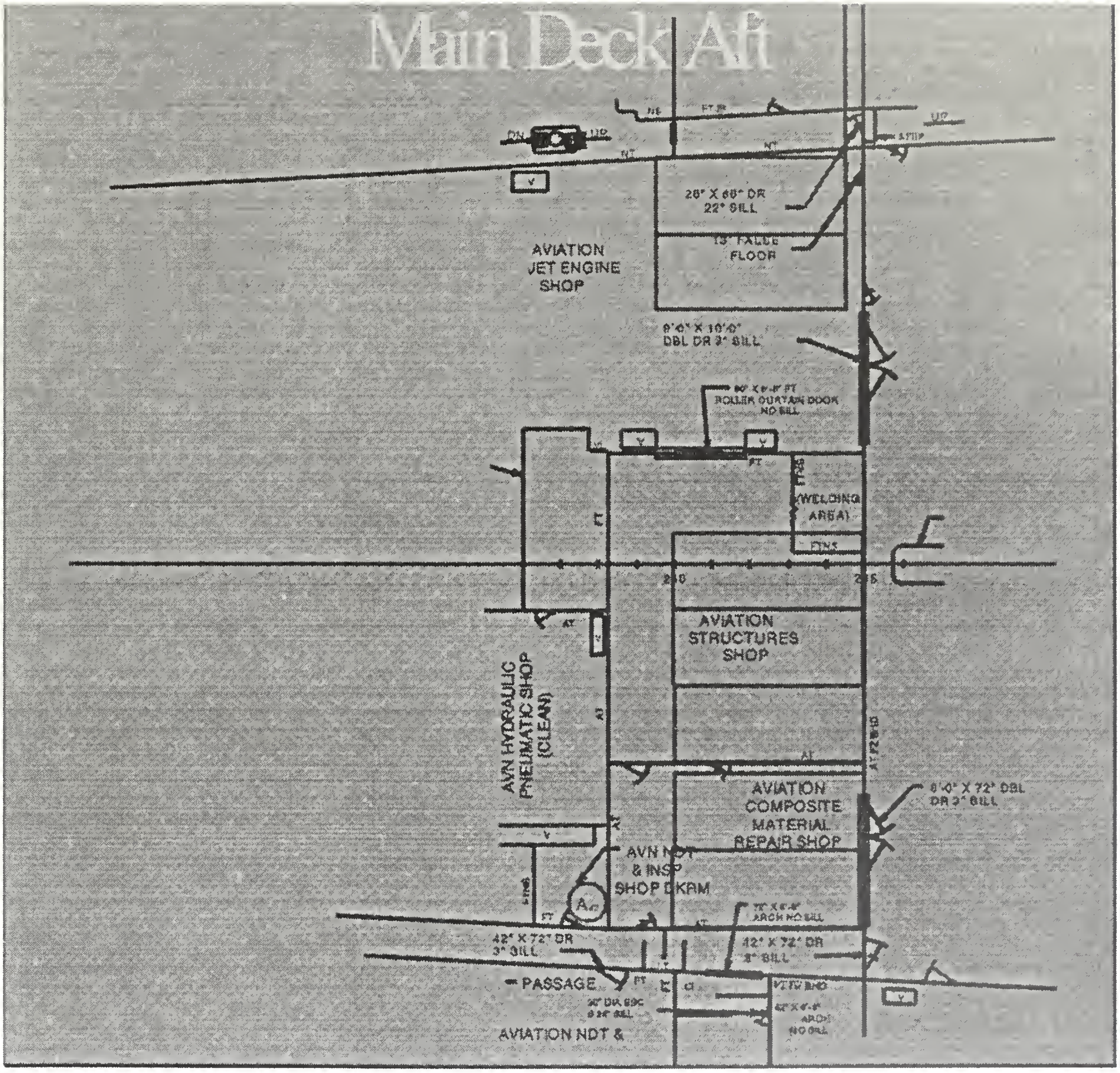
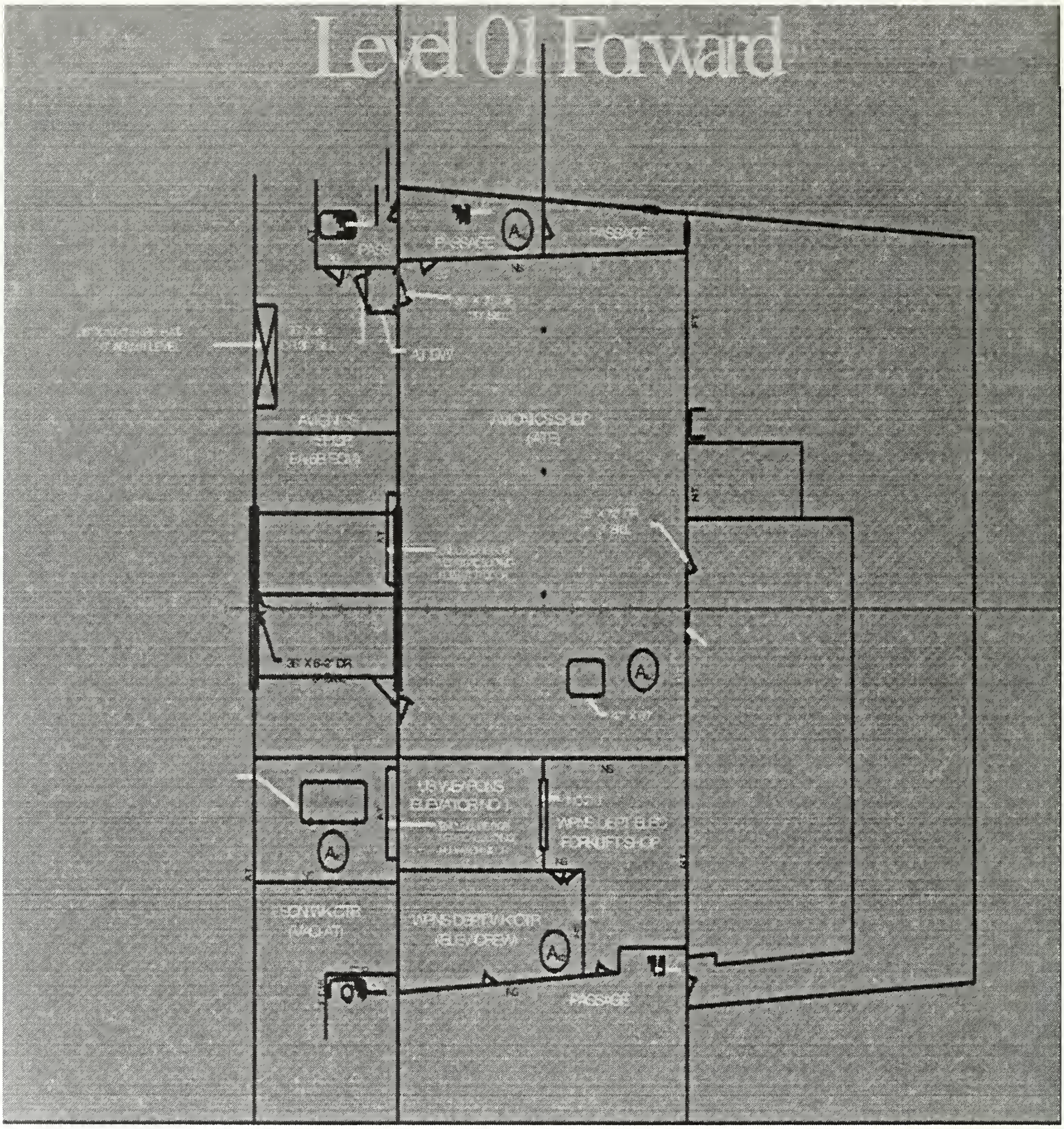
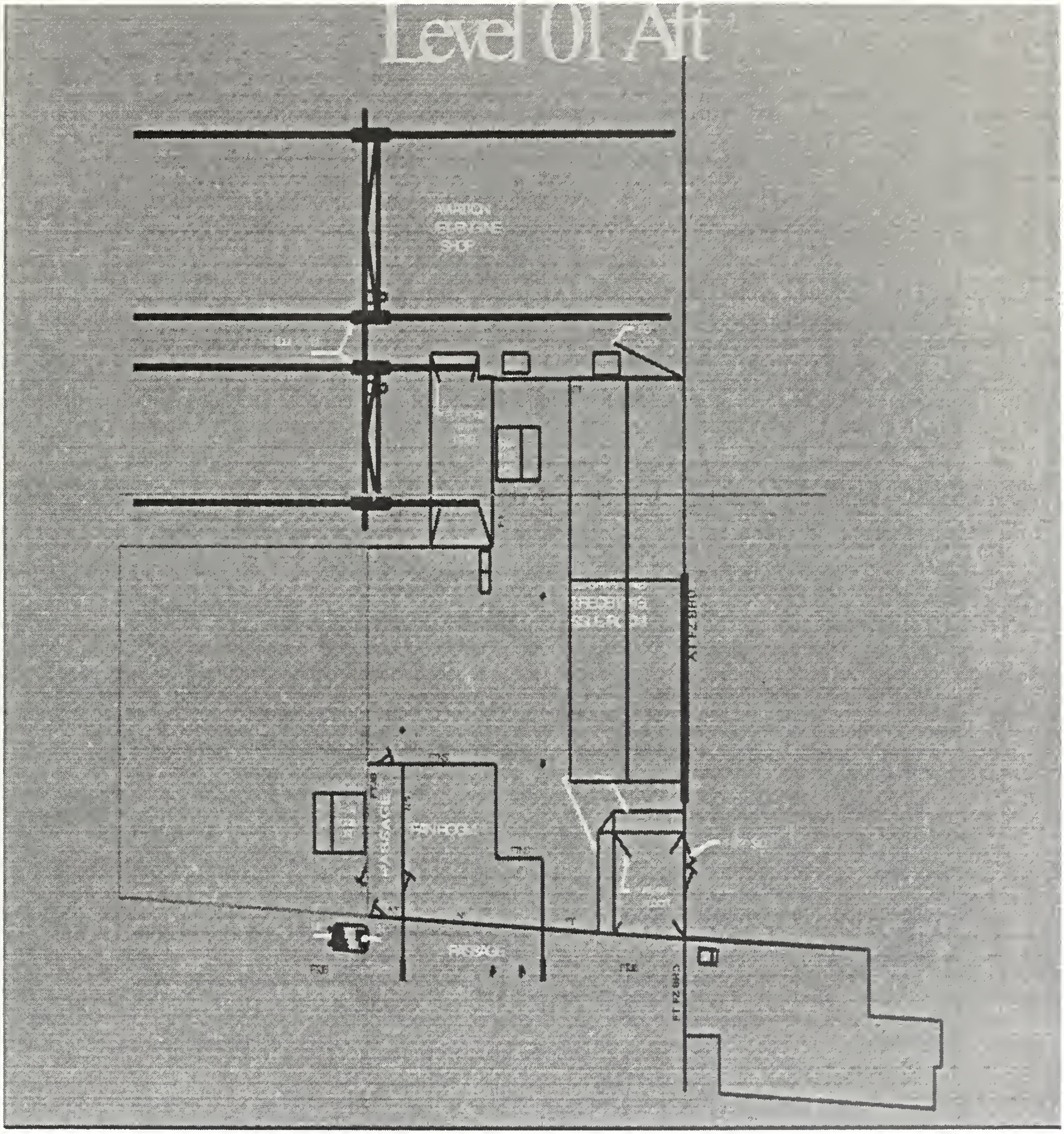
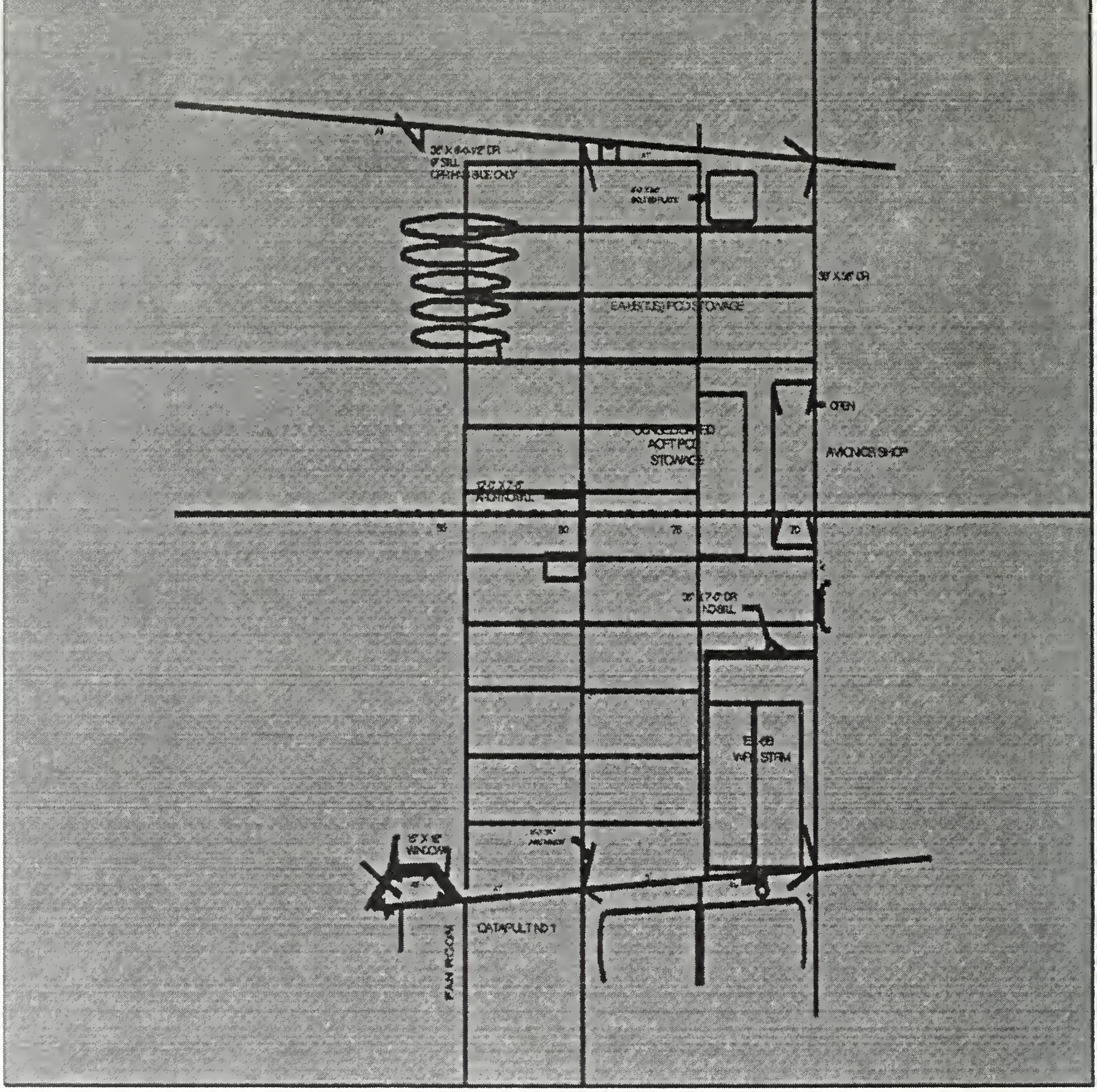
APPENDIX G. LAYOUT ONBOARD SHIP




Level 01 Forward
PASSAGE
PASSAGE
PASSAGE


Level 01 Aft
PASSAGE
PASSAGE

Level 02 Forward



APPENDIX H. AMD FROM USS J.C STENNIS (CVN-74)

BSC	Billet Title	Rate Req	Req PNEC	Actual Rate	Assgn Rate	Rate	DNEC1	INEC1
50005	**W/C 010 Maintenance Office**							
50010	A/C IMNT GEN	1520H			CDR			
50020	A/C IMNT/MTL	1520I			LCDR			
50030	A/C IMNT GEN	6380I			LCDR			
50040	A/C MNT QC	1520K		LT	LCDR			
50050	A/C IMNT PWRPL	1520J			LT			
50060	A/C IMNT AV	6380J			LTJG			
50070	A/C IMNT AV	7380O			CWO2			
50080	A/C IMNT SUPEQ	6330K			ENS			
50090	MP&T Coordinator	AZCM	9		AZCM	9 AZ	0000	0000
50100	SEAOPDET Coordinator	AZC	7		AZC	7 AZ	0000	0000
50100				AZ1	AZC	7 AZ	0000	6315
50120	**020 Maintenance/Production Control**							
50130	Production CTL Supvr	AVCM	9	8300	AVCM	9 AV	8300	0000
50140	Production CTL Supvr Asst	ASCS	8		AECS	8 AE	0000	8351
50150					AZC	7 AZ	0000	0000
50150	Prodcution CTL Supvr Asst	AZC	7		AZC	7 AZ	0000	0000
50160	Nalcomis DBA	AZ1	6	6314	AZ1	6 AZ	6314	6314
50170	Production CTL	AZ1	6		AZ1	6 AZ	0000	0000
50180	Nalcomis DBA Assist	AZ2	5	6314	AZ1	AZC	7 AZ	6314	6314
50190	Production CTL	AZ2	5			AZ3	4 AZ	0000	9760
50200	Production CTL	AZ2	5		AZAN	AZ3	4 AZ	0000	0000
50210	ECAMS Operator	AZ3	4	6301		AZ2	5 AZ	6301	6301
50220	ECAMS Operator	AZ3	4	6301	AZ2	AZ1	6	6301	6301
50230	Production CTL	AZ3	4		AN	AZ3	4 AZ	0000	0000
50240	Production CTL	AZ3	4		AZAA	AZAN	3 AZ	0000	0000
50250	Production CTL	AZAN							
50260	**030 Maintenance Administration**							
50270	AV Maintenance Admin	AZ1	6			AZ1	6 AZ	0000	0000
50270						AZ1	6 AZ	0000	0000
50280	AV Maintenance Admin	AZ2	5			AZ3	4 AZ	0000	0000
50290	AV Maintenance Admin	AZ3	4		AZ3	AZ2	5 AZ	0000	0000
50290						AZAR	3 AZ	0000	0000
50300	AV Maintenance Admin	AZAN							
50310	**040 Quality Assurance/Analysis**							
50320	Supervisor	ATCS	8						
50330	Quality Assurance Rep	ADC	7						
50340	Quality Assurance Rep	ATC	7			ATC	7 AT	6701	6701
50350	Quality Assurance Rep	AE1	6	6701		AE1	6 AE	6701	6701
50360	Quality Assurance Rep	AMH1	6	7213					
50370	Quality Assurance Rep	AMS1	6			AMS2	5 AMS	0000	8305
50380	Quality Assurance Rep	AO1	6	6802					
50390	Quality Assurance Rep	AS1	6			AS1	6 AS	7609	7609
50400	Quality Assurance Rep	AT1	6	6701		AT2	5 AT	9503	9503
50410	Tech Library	AZ1	6			AZ2	5 AZ	0000	0000
50420	Quality Assurance Rep	PR1	6			PR1	6 PR	0000	0000
50430	Tech Library	AZ3	4			AZ3	4 AZ	0000	0000
50440	**W/C 050 Material Control**							
50450	IMRL Manager	ASC	7		AK3	AK2	5 AK	9590	9590
50450						ASCS	8 AS	9590	9590

50460	AV Storekeeper	AK1	6			AKC	7	AK	2824	2824
50470	AV Storekeeper	AK2	5	8012		AK1	6	AK	8012	8012
50480	AV Storekeeper	AK2	5							
50490	AV Storekeeper	AK3	4		AKAN	AK3	4	AK	0000	0000
50500	Tool Room Attendent	AT3								
50510	AV Storekeeper	AKAN								
50520	**W/C 012 General Maint. Office (IM-2)**									
50530	Division Chief	ADCS	7			ADCS	8	AD	0000	8300
50540	Training Petty Officer	AD1	6			AD3	4	AD	0000	9760
50550	AV Maintenance Admin	AZ3	4		AZAA	AZAN	3	AZ	0000	0000
50560	**W/C 410 Jet Engine Branch**									
50570	Supervisor	ADC								
50580	Supervisor	AD1	6	6415						
50590	AV Machinist's Mate	AD2	5	6420		AD3	4	AD	6420	6420
50590					AN	ADAN	3	AD	6420	6420
50600	AV Machinist's Mate	AD3	4	6416	ADAA	ADAN	3	AD	6416	6416
50610	AV Machinist's Mate	AD3	4	6426		AD2	5	AD	6426	6426
50620	AV Machinist's Mate	ADAN	3	6421	ADAA	ADAN	3	AD	6421	6421
50630	AV Machinist's Mate	ADAN	3	6423						
50640	**W/C 41L T56 Engine Shop**									
50650	AV Machinist's Mate	AD2	5	6423						
50660	**W/C 450 Test Cell Branch**									
50670	Supervisor	AD1	6	6422		AD1	6	AD	6422	6422
50680	Test Cell Operator	AD2	5	6422	AD1	ADC	7	AD	6422	6422
50690	Test Cell Operator	AD3	4	6422		AD2	5	AD	6422	6422
50700	Test Cell Operator	ADAN	3	6422	ADAA	ADAN	3	AD	6422	6422
50710	Test Cell Operator	ADAN	3	6422	ADAR	ADAN	3	AD	6422	6422
50720	**W/C 460 Auxiliary Stores Branch**									
50730	Supervisor	AD1	6	8312		AD3	4	AD	8312	8312
50740	AV Electrician's Mate	AE3	4	8312		AE2	5	AE	8312	8312
50750	AM Hydraulics	AMHAN	3	8312						
50760	**W/C 470 NOAP Analysis Lab**									
50770	AV Machinist's Mate	AD2	5	6403		AD2	5	AD	6403	6403
50780	AV Machinist's Mate	AD2	5	6403	AD3	AD2	5	AD	6403	6403
50790	**W/C 51A Structures Shop**									
50800	Supervisor	AMSC	7		AMS1	AMSC	7	AMS	7232	7232
50810	Supervisor	AMS1	6	7232		AMS1	6	AMS	7232	7232
50820	AM Structures	AMS2	5	7232		AMS3	4	AMS	7232	7232
50830	AM Structures	AMSAN	3	7232						
50840	**W/C 51C Welding Shop**									
50850	Supervisor	AMS2	5	7222		AMS1	6	AMS	7222	7222
50860	AM Structures	AMS3	4	7222		AMS3	4	AMS	7222	7222
50870	**W/C 51E Tire/Wheel Shop**									
50880	Supervisor	AMS1	6			AMS1	6	AMS	0000	8345
50890	AM Structures	AMS2	5			AMS3	4	AMS	0000	0000
50890						AMSA N	3		0000	0000
50890						AN	3	AN	0000	0000
50900	AM Structures	AMSAN	3		AMSA R	AMSA N	3	AMS	0000	0000
50910	**W/C 51F Composites Repair Shop**									
50920	Supervisor	AMS1	6	7232						
50940	**W/C 52A Hydraulic Shop**									
50950	Supervisor	AMHC	7							
50960	Supervisor	AMH1	6	7213		AMH1	6	AMH	7213	7213
50960						AMH1	6	AMH	7212	7212

50970						AMH2	5	AMH	7212	7212
50970	AM Hydraulics	AMH2	5	7212		AMH2	5	AMH	7212	7212
50980	**W/C 530 NDI Branch Nondestructive Inspection**									
50990	Supervisor	AMS1	6	7225		AMS1	6	AMS	7225	7225
51000	AM Structures	AMS3	4	7225		AMS2	5	AMS	7225	7225
51000						AMS3	4	AMS	7225	7225
51010	**W/C 013 Avionics Armament Office**									
51020	Division Chief	ATCS	8			ATCS	7	AT	0000	6527
51030	AV Maintenance Admin	AZ2	5		AZ3	AZ2	5	AZ	0000	6301
51040	AV Maintenance Admin	AZ3	4			AZ3	4	AZ	0000	0000
51050	AV Maintenance Admin	AZAN								
51060	**W/C 60A Avionics Corrosion Control**									
51070	AV Electronics Tech	AT2	5			AT3	4	AT	0000	6526
51070						AT3	4		0000	0000
51070						AT3	4	AT	0000	0000
51070						ATAN	3	AT	0000	0000
51070						ATAN	3	AN	0000	0000
51070					ATAR	ATAN	3	AT	0000	0000
51080	**W/C 61A Communication Shop**									
51090	Supervisor	ATC	7			ATC	7	AT	0000	6718
51100	Supervisor	AT1	6	6701		AT1	6	AT	6701	6701
51110	AV Electronics Tech	AT3	4	6611						
51120	AV Electronics Tech	ATAN	3	6609						
51130	**W/C 61B Navigation Shop**									
51140	Supervisor	AT1	6	6701						
51150	AV Electronics Tech	AT2	5	6612		AT1	6	AT	6608	6608
51160	AV Electronics Tech	ATAN	3	6605						
51170	**W/C 61D COMSEC/Crypto Shop**									
51180	Supervisor	AT2	5	6634		AT1	6	AT	6634	6634
51190	AV Electronics Tech	AT3	4	6634	ATAN	AT3	4	AT	6634	6634
51200	**W/C 62A Electric Shop**									
51210	Supervisor	AEC	7			AEC	7	AE	0000	8342
51220	Supervisor	AE1	6	7144		AE2	5	AE	7144	7144
51230	AV Electrician's Mate	AE2	5	7184		AE1	6	AE	7184	7184
51240	ECAMS Maintenance	AE2	5	6714		AEAN	3	AE	6714	6714
51250	**W/C 62B Instrument Shop**									
51260	Supervisor	AE1	6	7137		AE1	6	AE	7137	7137
51270	**W/C 62C Battery Shop Lead Acid**									
51280	Supervisor	AE2	5			AE2	5	AE	0000	0000
51290	AV Electrician's Mate	AEAN								
51300	**W/C 62D Battery Shop, Nickel Cadmium**									
51310	Supervisor	AE2	5			AE3	4	AE	0000	0000
51320	AV Electrician's Mate	AEAN	3		AEAN	AE3	4	AE	0000	0000
51330	**W/C 62E CSD/Generator Shop**									
51340	Supervisor	AE2	5	7131		AE2	5	AE	7131	7131
51350	**W/C 62F Inertial Navigation Shop**									
51360	Supervisor	AE1	6	7197		AE2	5	AE	7197	7197
51370	AV Electrician's Mate	AE2	5	7197		AE2	5	AE	7197	7197
51380	**630 Fire Control Branch**									
51390	Supervisor	AT1	6	7978		AT1	6	AT	7978	7978
51400	AV Electronics Tech	AT3	4	7978	ATAN	AT3	4	AT	7978	7978
51410	**W/C 63A AWG-9 Shop**									
51420	Supervisor	ATC	7			ATC	7	AT	0000	7978
51430						AT1	6	AT	7992	7992

51430	AV Electronics Tech	AT1	6	7992		AT2	5	AT	7992	7992
51440	AV Electronics Tech	AT2	5	7984	AN	ATAN	4	AT	7984	7984
51450	AV Electronics Tech	AT3	4	7988	ATAA	ATAN	4	AT	7988	7988
51460	AV Electronics Tech	AT3	4	7989		ATAN	4	AT	7989	7989
51470	AV Electronics Tech	AT3	4	7991		AT2	5	AT	7991	7991
51480	**W/C 64A Radar Shop**									
51490	Supervisor	AT1	6	6621		AT1	6	AT	6621	6621
51500	AV Electronics Tech	ATAN	3	6614	ATAA	ATAN	3	AT	6614	6614
51510	**W/C 64B ECM Shop**									
51520	Supervisor	AT1	6	6686						
51525	Supervisor	AT1		6648						
51530	AV Electronics Tech	AT2		6647						
51540	AV Electronics Tech	AT2		6680						
51580	**W/C 64C DECM Shop**									
51590	Supervisor	ATC	7			ATC	7	AT	0000	8306
51600	Supervisor	AT1	6	6701		AT1	6	AT	6701	6701
51610	AV Electronics Tech	AT2	5	6618		AT1	6	AT	6618	6618
51620	AV Electronics Tech	ATAN	3	6618		AT2	5	AT	6618	6618
51630	**W/C 64D FLIR Shop**									
51640	Supervisor	AT1	6	6684	AT1	ATC	7	AT	6684	6684
51650	AV Electronics Tech	AT2	5	6631		AT1	6	AT	6631	6631
51660	**65A RADCOM**									
51670	Supervisor	AT1	6	6633		AT1	6	AT	6633	6633
51680	AV Electronics Tech	AT2	5	6633		AT3	4	AT	6633	6633
51690	AV Electronics Tech	ATAN	3	6633	ATAA	ATAN	3	AT	6633	6633
51700	**W/C 65B CASS**									
51710	Supervisor	ATC	7			ATC	7	AT	0000	6688
51720	Supervisor	AT1	6	6705		AT1	6	AT	6705	6705
51730	AV Electronics Tech	AT1	6	6704	ATAN	AT3	4	AT	6704	6704
51740	AV Electronics Tech	AT2	5	6658		AT2	5	AT	6650	6650
51750	AV Electronics Tech	AT2	5	6705		AT1	6	AT	6705	6705
51760	AV Electronics Tech	AT2		6705						
51770	AV Electronics Tech	AT2		6705						
51780	AV Electronics Tech	AT2		6713	AT3	AT2	5	AT	6713	6713
51790	AV Electronics Tech	AT3		6704						
51800	AV Electronics Tech	AT3		6704						
51810	AV Maintenance Admim	AZ3	4		AN	AZ3	4	AZ	0000	0000
51820	AV Electronics Tech	ATAN	3	6704		ATAN	3	AT	6704	6704
51830	AV Electronics Tech	ATAN	3	6704						
51840	AV Electronics Tech	ATAN	3	6704	ATAN	AT3	4	AT	6704	6704
51850	**W/C 660 ASW Branch**									
51860	AV Electronics Tech	AT2	5	6527		AT3	4	AT	6527	6527
51870	**670 PME Branch/Field Calibration**									
51880	Supervisor	ATC	7			ATC	7	AT	0000	6699
51890	Supervisor	AT1	6	6718		AT1	6	AT	6718	6718
51900	Petty Officer	ET1	6	6673		ET2	5	ET	1589	1589
51910	AV Electronics Tech	AT2	5	6718		AT1	6	AT	6718	6718
51920	AV Electronics Tech	AT2	5	6718		AT2	5	AT	6718	6718
51930	Petty Officer	ET2	5	6673	ET3	ET2	5	ET	1589	1589
51940	Petty Officer	ET2	5	6673		ET2	5	ET	1589	1589
51950	Petty Officer	AT3	4	6673		AT1	6	AT	6673	6673
51960	Petty Officer	AT3	4	6673		AT3	4	AT	6673	6673
51960						AT3	4		6673	6673
51970	Petty Officer	AT3	4	6673		ET3	4	ET	6673	6673
51980	Petty Officer	ET3	4	6673	ETSN	ET3	4	ET	1589	1589

51990	Petty Officer	ET3	4	6673	ATAN	AT3	4	AT	6673	6673
52000	AV Electronics Tech	ATAN	3	6673	AT3	AT2	5	AT	6673	6673
52000	AV Electronics Tech	ATAN	3	6673	ATAN	AT3	4	AT	6673	6673
52010	AV Electronics Tech	ATAN	3	6673	ATAN	AT3	4	AT	6673	6673
52020	AV Electronics Tech	ATAN	3	6673	ATAA	ATAN	3	AT	6673	6673
52030	AV Supp Equip Tech	AS2	5	7610		AS3	4	AS	7610	7610
52030	AV Electronics Tech	ATAN	3	6673		AT3	4	AT	6673	6673
52040	**W/C 67A PME Receipt & Issue**									
52050	PME Receipt/Issue	AE2	5		AEAN	AE3	4	AE	0000	0000
52060	PME Receipt/Issue	AN								
52070	**W/C 69A Module Test/Troubleshooting**									
52080	Supervisor	ATC	7			ATC	7		0000	6718
52090	Supervisor	AT1	6	6686	AT1	ATC	7	AT	6686	6686
52100	AV Electronics Tech	AT1	6	6689		AT1	6	AT	6689	6689
52110	AV Electricians Mate	AE2	5	7173		AEAN	3	AE	7173	7173
52120	AV Electronics Tech	AT2	5	6628		AT2	5	AT	6628	6628
52130	AV Electronics Tech	AT2	5	6689						
52140	AV Electronics Tech	ATAN	3	6686	ATAN	AT3	4	AT	6686	6686
52150						AT3	4	AT	6688	6688
52150					ATAN	AT3	4	AT	6688	6688
52150	AV Electronics Tech	ATAN	3	6688	ATAA	ATAN	3	AT	6688	6688
52160	**W/C 69B Micro/Mini Repair Shop**									
52170	Supervisor	AT1	6			AT1	6	AT	9526	9526
52170						AT1	6	AT	9526	9526
52180	Aviation Petty Officer	AT3	4		ATAN	AT3	4	AT	9527	9527
52190	**W/C 69C Cable/Connector Repair Shop**									
52200						AE2	5	AE	9527	9527
52200	Supervisor	AE2	5		AE3	AE2	5	AE	9527	9527
52200					ATAA	ATAN	4	AT	9527	9527
52200					ATAA	ATAN	4	AT	9527	9527
52210	**W/C 710 Ordnance Branch**									
52220	Supervisor	AOC	7	6802		AOC	7	AO	6802	6802
52230	Supervisor	AO1	6	6802		AO1	6	AO	6802	6802
52240	AV Maintenance Admin	AZ3	4							
52250	AV Ordnanceman	AOAN	3	6802	AO3	AO2	5	AO	6802	6802
52250						AO2	5	AO	6802	6802
52260	AV Ordnanceman	AOAN		6802						
52280	**W/C 71A Armament Equipment Pool**									
52290	AV Ordnanceman	AO2	5	6802		AO2	5	AO	6802	6802
52300	AV Ordnanceman	AO3		6802						
52310	AV Ordnanceman	AOAN	3	6802		AO3	4	AO	6802	6802
52320	AV Ordnanceman	AOAN		6802						
52330	AV Ordnanceman	AOAN		6802						
52340	AV Ordnanceman	AOAN		6802						
52350	**W/C 81A Parachute Shop**									
52360	Supervisor	PRC	7			PRC	7	PR	0000	0000
52370	Supervisor	PR1	6	7356						
52380	Aircrew Survival Equipment	PRAN	3		PRAA	PRAN	3	PR	0000	0000
52390	**W/C 81B Aviators Safety Equipment Shop**									
52400						PR2	5		7356	7356
52400	Supervisor	PR2	5	7356		PR2	5	PR	7356	7356
52410	**W/C 81C Oxygen Regulator & Equipment**									
52420	Aircrew Survival Equipment	PR2	5	7356		PR2	5	PR	7356	7356
52430	**W/C 014 Support Equipment Office**									
52440	Division Chief	ASCS	8	7609	ASCS	ASCM	9	AS	7609	7609
52450	AV Maintenance Admin	AZ3	4		AZAA	AZAN	3	AZ	0000	0000

52460	**W/C 901 Supprt Equip Treining/License**								
52470	GSE OP/License Instructor	AS1	6			ASC	7 AS	9502	0000
52480	**W/C 903 Support Equipment Meteriel**								
52490	AV Storekeeper	AK1	6			AK2	5 AK	0000	0000
52500	AV Storekeeper	AK2	5						
52510	AV Supp Equip Tech	AS2	5						
52520	AV Storekeeper	AK3	4			AK3	4 AK	0000	0000
52530	AV Storekeeper	AKAN							
52540	**W/C 029 Support Equipment Production**								
52550	Supervisor	ASC	7	7609		ASC	7 AS	7609	7609
52560	Supervisor	AS1	6	7609		AS1	6 AS	7609	7609
52570	AV Supp Equip Tech	AS2	5	7609		AS2	5 AS	7609	7609
52580	AV Maintenance Admin	AZ2	5			AZ2	5 AZ	6314	6314
52590	AV Maintenance Admin	AZAN							
52600	**W/C 90A Support Equipment Pool**								
52610	AV Supp Equip Tech	AS2	5						
52620	AV Supp Equip Tech	ASAN	3		ASAA	ASAN	3	0000	0000
52630	AV Supp Equip Tech	ASAN	3			ASAN	3 AS	0000	0000
52640	AV Supp Equip Tech	ASAN	3			ASAN	3 AS	0000	0000
52650	**W/C 910 Support Equipment Ges Engine Repeir Brench**								
52660	Supervisor	AS1	6	7617		AS1	6 AS	7617	7617
52670	AV Supp Equip Tech	AS2	5	7618		AS2	5 AS	7618	7618
52670						AS3	4 AS	7618	7618
52680	AV Supp Equip Tech	AS3	4	7606		AS2	5 AS	7606	7606
52690	AV Supp Equip Tech	AS3	4	7618	AS3	AS2	5 AS	7618	7618
52700	AV Supp Equip Tech	ASAN	3	7617	AS3	AS2	5 AS	7617	7617
52710	AV Supp Equip Tech	ASAN	3	7618	ASAA	ASAN	3 AS	7618	7618
52720	AV Supp Equip Tech	ASAN	3	7618	ASAN	AS3	4 AS	7618	7618
52730	**W/C 920 Support Equipment Structiel/HYT Branch**								
52740	Supervisor	ASC	7	7609		AS1	6 AS	7609	7609
52750	AV Supp Equip Tech	AS1	6	7618		AS1	6 AS	7618	7618
52760	AV Supp Equip Tech	AS2	5	7612		AS2	5 AS	7222	7222
52770					AS3	AS2	5 AS	7612	7612
52770	AV Supp Equip Tech	AS2	5	7612	AS3	AS2	5 AS	7612	7612
52780	AV Supp Equip Tech	AS3	4	7610					
52790	AV Supp Equip Tech	AS3		7610					
52800	AV Supp Equip Tech	AS3	4	7618					
52810	AV Supp Equip Tech	ASAN	3	7612	ASAR	ASAN	3	7612	7612
52820	AV Supp Equip Tech	ASAN	3	7618	AS3	AS2	5 AS	7618	7618
52820					ASAA	ASAN	3 AS	7618	7618
52830	AV Supp Equip Tech	ASAN	3	7618		AS2	5 AS	7618	7618
52840	AV Supp Equip Tech	ASAN	3	7618	AS2	AS1	6 AS	7618	7618
52840						ASAN	3 AS	7618	7618
52850	AV Supp Equip Tech	ASAN		7618					
52860	**W/C 92C Lox/Oxy/Nitro Equipment Repeir Shop**								
52870	AV Supp Equip Tech	AS2	5	7601		AS2	5 AS	7601	7601
52870					ASAN	AS3	4 AS	7601	7601
52870						ASAN	3 AS	7601	7601
52880	**W/C 930 Support Equipment Electricel Repeir Brench**								
52890	AV Supp Equip Tech	AS2	5	7615	ASA	ASAN	3 AS	7615	7615

					A				
52900	AV Supp Equip Tech	AS3	4	7615	AS3	AS2	5 AS	7615	7615
52910						AS3	4 AS	7615	7615
52910	AV Supp Equip Tech	ASAN	3	7615		AS3	4 AS	7615	7615
52910					ASAA	ASAN	3 AS	7615	7615
52920	**W/C 940 Support Equipment Component Repair Branch**								
52930	AV Supp Equip Tech	AS2	5	7615	ASAR	ASAN	3 AS	7612	7612
52940	**W/C 950 Support Equipment Periodic Maintenance Branch**								
52950	AV Supp Equip Tech	AS2	5	7615		AS2	5 AS	7615	7615
52960	AV Supp Equip Tech	AS3	4	7612	ASAA	ASAN	3 AS	7612	7612
52970	AV Supp Equip Tech	ASAN	3	7618		AS3	4 AS	7618	7618
52980	**W/C 970 Air Conditioning Repair**								
52990	AV Supp Equip Tech	AS2	5	7603		AS1	6 AS	7603	7603
53000	AV Supp Equip Tech	AS3	4	7603	ASAA	ASAN	3 AS	7603	7603
53010	**W/C 980 Flight Deck Troubleshooting Branch**								
53020	AV Supp Equip Tech	AS1	6	7615		AS2	5 AS	7615	7615
53040	AV Supp Equip Tech	AS2	5	7618		AS3	4 AS	7618	7618
53050	AV Supp Equip Tech	AS3	4	7606		AS1	6 AS	7606	7606
53060	AV Supp Equip Tech	AS3	4	7612		ASAN	3 AS	7612	7612
53070	AV Supp Equip Tech	AS3	4	7617		AS2	5 AS	7617	7617
53080	**XXO Ship's Evolutions**								
53085	DEPT 3M ASST	APOC							
53090	Supervisor	AS1	6			AS2	5 AS	0000	7614
53100	DMG CTL PO/ASST U T Sup	AS2	5			AS2	5 AS	0000	7614
53110	Damage Control PO	AS2	5			AS3	4 AS	0000	0000
53120	Damage Control PO	AE2							
53130	Utility Task Support	AN	3		AA	AN	3 AN	0000	0000
53140	Utility Task Support	AN	3			AN	3 AN	0000	0000
53140					AA	AN	3 AN	0000	0000
53150	Utility Task Support	AN							
53160	Utility Task Support	AN							
53170	Utility Task Support	AN							
53180	Utility Task Support	AN							
53190	Utility Task Support	AN							
53200	Utility Task Support	AN							
53210	Utility Task Support	AN							
53220	Utility Task Support	AN							
53230	Utility Task Support	AN							
53240	Utility Task Support	AN							
	Not needed under new AMD					AD1	AD	6410	6410
	Not needed under new AMD					AD2	AD	6410	6410

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APPENDIX I. QUESTIONNAIRE

1. In general, what workcenters would you apply the Mobile Facilities (MF) and which would you not? Why or why not?
2. Would you change the remaining workcenter structure onboard the ship (i.e. Cal lab goes to another department, or part/all of IM-4 fall under Air Department)? When would this apply (ashore and/or at sea)?
3. What demands modularization (customer-sqdrn, demands, T/M/S embarked, technology, etc)?
4. What impact will MFs have on CASS or its follow on system?
5. What occurs to maintenance manning, both onboard and ashore?
   - Impact on SEAOPDET?
   - Impact on AIMD ashore?
   - Impact on training and advancement?
   - Who remains on the ship to ensure AIMD gets a voice during availabilities?
6. What are the strengths and weaknesses of implementing this concept?
7. When would it be prudent to offload MFs and when would it not (i.e. Btwn end of deployment and IDTC, PIA, shipyard overhauls)
8. What happens to the AMDO ? When MFs go ashore, which officers go and who do they work for?
9. Aside from the transportation costs, what additional costs might need to be considered?
10. What impact will JSF, CSA, and other follow-on aircraft have if the MF is adopted?
11. What supply/logistical consequences do you foresee if implemented?
12. Any additional comments?

PRIVACY ACT STATEMENT

The following information is provided as required by the Privacy Act of 1974

a. Authority: 5 USC 301
b. Principal purpose: To sample military opinion and attitudes concerning MFs in AIMD.
c. Routine use: To provide data as part of a Naval Postgraduate School Master's thesis.
d. Participation in this questionnaire is voluntary and respondents will not be identified.
e. No adverse action of any kind will be taken against any individual who elects not to participate in any or all parts of this questionnaire.

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